NUTRITION

IN

HEALTH AND DISEASE.

Works by the Author.

I.

A PRACTICAL TREATISE

ON

INFLAMMATION OF THE UTERUS,

ITS CERVIX AND APPENDAGES;

AND ON ITS CONNEXION WITH UTERINE DISEASES.

8vo, pp. 532, 3rd Edition.

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A REVIEW OF THE PRESENT STATE OF UTERINE PATHOLOGY.

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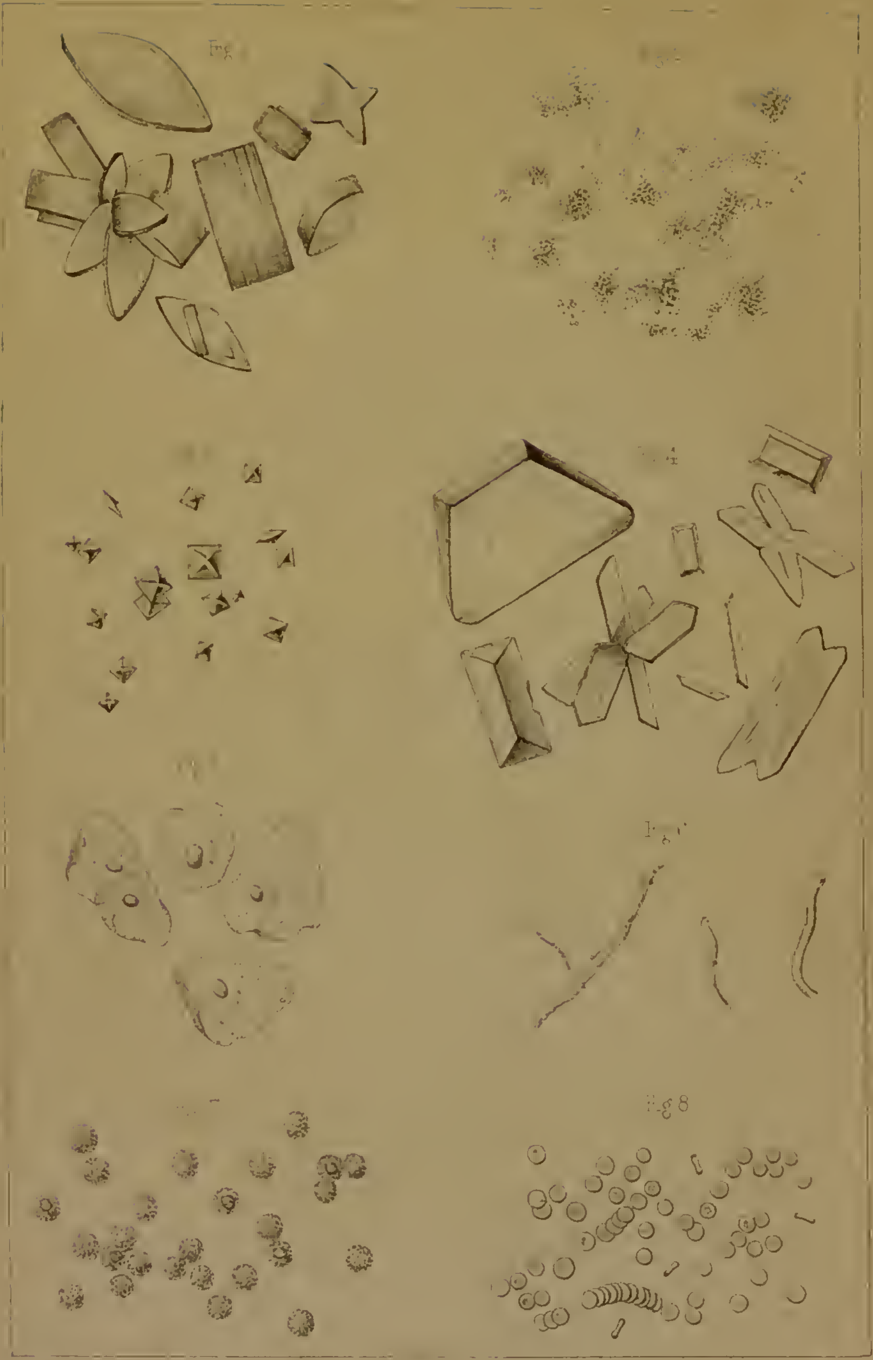
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CONTENTS.

CHAPTER V.

CHAPTER VI.

PREFACE.

My object in writing the following work has been forcibly to draw attention to the fact, often overlooked, that the imperfect performance of the digestive and nutritive functions leads, slowly but surely, to ill health, to disease, and to death. In order to make myself perfectly intelligible, I have prefaced the pathological details into which I have entered with a brief account of normal digestion and nutrition, as elucidated by modern physiological and chemical research.

The physiological facts and doctrines advanced are those generally received, and will be found more or less developed in all recent treatises on physiology. I am fully aware that some of these doctrines are still a subject of discussion between recent experimentalists, but I have not thought it desirable to

reproduce their different opinions. Had I done so, I might have rendered the work more complete, but I should have also marred the brevity and clearness by which I am desirous it should be characterised.

The pathological facts and opinions brought forward are deduced from my own individual experience, and were briefly enunciated ten years ago, in the second edition of my work on Uterine Inflammation, published in 1848. They agree, in the main, with the views entertained by most modern writers on nutrition and on urinary deposits.

There is, however, one point on which I join issue with many who have specially treated of urinary deposits. I believe that too much importance has been attached to the *differential diagnosis* of the different morbid salts which are found in the urine as a result of disordered digestion and nutrition. I attribute even more importance to the presence of these deposits, as evidences of perturbation of the digestive and nutritive processes, than is usually attributed to them; but after many years' research, I have not been able to establish to my own satisfaction that the different morbid salts have always, or indeed generally, a different pathological meaning.

It appears to me that, in disordered nutritive states, all, or nearly all, may occur and constantly do occur under the same circumstances.

If such is the case, the prevailing views in this very important department of pathology may possibly admit of simplification, and be thereby rendered more practical. It is with no slight hesitation that I have made an attempt in this direction; but I have gathered courage from the reflection that the generalizations of a practical physician, who is constantly seeing and treating chronic as well as acute disease, may not be without some value, even in a field occupied by much more learned labourers.

I trust that I shall not be considered presumptuous, if I express the hope that this little work may contribute to convince my medical brethren of the imperative necessity of studying dietetics in connexion with chemistry and physiology. Apart from such a basis, all dietetic views and regulations must be fallacious. No medical practitioner is, in reality, capable of regulating the diet of his patients in a sound and satisfactory manner, unless he know and bear in mind the chemical nature of

the food that he recommends, what it is destined to effect, and what eventually becomes of it,—whether perfectly or imperfectly digested.

In conclusion, I would remark, that the tendency which is rapidly gaining ground to look upon the diseases of the present day as presenting an asthenic character, and as requiring high feeding and stimulants more than depletion and a low diet, renders this knowledge all the more necessary. It should ever be remembered, that to give a large quantity of food to a patient, however weak and emaciated, which he cannot and does not properly digest, is partially to poison him. On the one hand, imperfectly digested food does not nourish; on the other, it has to be eliminated from the economy as noxious matter;—yet this is an error which is constantly committed.

60, Grosvenor Street,

September 1*st*, 1858.

CHAPTER I.

DIGESTION AND NUTRITION IN HEALTH.

Under the general term of Nutrition may be comprised the various functions and operations through the agency of which the animal economy is developed, its waste is repaired, and its heat is maintained.

Life begins in man, as in all animated nature, by a cell or a series of cells. During fœtal life the materials of nutrition are elaborated and supplied by the mother. But from the moment that parturition has taken place, that the link which united mother and child has been severed, and that the latter begins to live an independent existence, its nutrition must be the result of the action of its organization upon "the materials of nutrition" supplied from the outer world.

The materials of nutrition are obtained from the atmospheric air breathed and from the food

consumed. Out of these materials the organization of the new-born child, perfect in itself, but rudimentary in its development, has to be increased, completed, and repaired.

The human frame is composed, chemically speaking, of gases, oxygen, hydrogen, and nitrogen, of carbon, and of various inorganic salts, phosphate, and carbonate of lime, sulphur, chloride of calcium, &c. These are the chemical elements which are eliminated from the air and from food. The nutritive elements supplied by the atmosphere which surrounds the earth, through the function of respiration, are always the same, and if the atmosphere is pure, are supplied in the same proportions. They are beyond our control, inasmuch as respiration is carried on from birth to death independently of the will. Food contains the required chemical elements of nutrition in variable proportions, and instinct guides man, and all animated beings, in the choice of the kind of food required by his and their organizations. This instinct, however, may be, and often is, marred or perverted in man. Having reason to guide and direct him, the food-instinct is not so strong with him as it is with the brute creation, the members of which generally limit themselves to the kind of food upon which nature has intended them to live

and thrive. It behoves man, therefore, to make use of his reason, to study himself, and thus to enable his intellect to direct his appetites and food-desires.

The body is principally formed of the three gases above enumerated, oxygen, hydrogen, and nitrogen, and of carbon, transformed and solidified by nature's chemistry. The inorganic salts occupy a subordinate but indispensable position. These salts are mainly employed in forming and giving solidity to the tissues, bones, cartilages, muscles, &c. They are contained in greater or less, but in sufficient quantity, in the various articles of food consumed by animated beings, so that they enter the economy with the food, imperceptibly, mysteriously, as it were, perform their duty, and are eliminated, without the individual having to look for them, or being conscious, indeed, of their presence, or of the inorganic requirements of his own organization.

In the vegetable world, carbon is the all-important and predominating elementary substance. Hydrogen and oxygen also exist in abundance, either united as water, or in other forms of combination. Nitrogen is scarcely found in some vegetable productions, and seldom constitutes more than from one to four per cent. of the whole, even in the

vegetable substances which contain it in the largest proportion, such as wheat, oats, hay, &c. In the animal world, nitrogen appears to be in the ascendant, and to constitute the most important element in the animal formation; carbon, oxygen, and hydrogen occupying a secondary position.

Even in the animal creation, however, carbon constitutes the greater part of the bulk. Thus lean beef, white of egg, and the curd of milk, when quite dry, present the following proportions (Professor Johnston):—

	PER CENT.
Carbon	55
Hydrogen	7
Nitrogen	16
Oxygen, with a little sulphur and phosphorus . .	22
	100

The greater amount of nitrogen contained in animal substances, as compared with vegetable, appears, however, to thoroughly modify their anatomical and physical character, and warrants the distinction generally recognised and established between carbonaceous and nitrogenous, or vegetable and animal, organizations.

This simple fact is at the bottom of the entire

theory of nutrition in the organic creation. The framework of an animal being, to a great extent, formed of nitrogen, it is clear that if the animal is not carnivorous, does not live on flesh, it must consume vegetable food containing nitrogen. And such is the case; the grains and grasses on which granivorous and herbivorous animals live, all contain, in addition to the carbon, considerable quantities of nitrogen. Carnivorous animals make and repair their nitrogenous flesh-tissues from the nitrogenous flesh of the herbivorous animals; while the latter, as we have seen, elaborate it directly from the vegetable world. Man, occupying a medium position, and being carnivorous, herbivorous, and granivorous, can extract the nitrogen he requires either from animal or from vegetable substances, or from both simultaneously. In the first case, he transforms directly the flesh of the nitrogenous tissues of animals into his own; in the second, he extracts from the vegetables he consumes their small per centage of nitrogen; and, in the third, he forms and repairs his own flesh on nitrogen extracted indiscriminately from both kingdoms. In all three, he combines the nitrogen extracted from food with oxygen supplied from the atmosphere through respiration, in the formation of his tissues.

From the above facts, it must be apparent that man, a considerable proportion of whose body is composed of nitrogen, is compelled to seek nitrogen in his food to complete his structures and to repair their waste. Nitrogen, therefore, he does seek, and finds, in abundance, in animal substances, flesh, milk, eggs, &c., and also in a smaller ratio in vegetable articles of diet.

Man, however, like all warm-blooded animals, has not only to complete and renovate the structures which constitute his body,—he has also, from the hour of his birth to that of his death, to *create heat*, in more or less abundance, according to the temperature of the atmosphere by which he is surrounded. Owing to the laws of radiation of heat, there is a constant tendency in all bodies, animate or inanimate, to abandon surplus heat to the medium in which they are placed. In the warm-blooded animal creation, this tendency is only counteracted by the constant generation of heat, which is a result, partly of real combustion, and partly of the more intimate vital, electric, and nutritive changes that are constantly taking place in the tissues of the economy. When death supervenes, and these operations cease, the body, at first warm, rapidly loses its heat, and becomes of the same temperature as the surrounding atmosphere.

Thus, during life, the animal body is a walking fire, consuming fuel, in the shape of food on the one hand, and of its own detritus on the other, which it combines with oxygen derived from the atmosphere during respiration. In a climate like ours, a very considerable proportion of the food taken is thus consumed in keeping up the animal heat.

Combustion, in the external world, is principally supported by the combination with the oxygen of the atmosphere of carbonaceous substances, such as vegetable products, wood, charcoal, coal, &c., and fats and oils, which are hydrocarbon compounds. Their rapid chemical combination with oxygen is attended with the evolution of heat and light. Were the combination to take place more slowly, heat would still be evolved, but light would not. This is what occurs in the animal economy. The carbon of vegetable food,—the principal element of such food,—and that of fatty substances and of alcoholic beverages rich in carbon, combines with the oxygen introduced into the circulation by respiration, forms carbonic acid, and evolves heat.

Thus we see that the nitrogenous element in food, represented by flesh or animal substances, is principally required to perfect the tissues of the economy, and to repair their waste; whilst the

carbonaceous element, which is represented by vegetable articles of diet, by fats and oils, and by alcoholic beverages, is principally required, as fuel, to support the silent combustion which is constantly going on in the animal system, and to which is mainly due the generation of animal heat. It is now generally admitted that the more intimate processes of nutrition, which consist in the constant formation and disintegration of the tissues of which the economy is formed under the influence of the nervous system, are also attended with the evolution of latent heat in considerable quantities. These sources of heat continue to create it incessantly as long as life lasts, ceasing their operation with life only.

Having thus briefly stated what nutrition is, and analysed the materials on which it depends, I shall now examine the various stages of elaboration through which these materials have to pass. It is not my intention, however, to enter minutely into the history of the various functions which, by their united action, constitute digestion and nutrition. I am merely desirous to give a brief sketch of the facts established by the researches of modern physiologists, in order to render intelligible the subject of nutrition in general, and more especially that of morbid nutrition.

SOLID FOOD, ITS ELABORATION AND DESTINATION.

Liquid food introduced into the mouth is swallowed at once and passes into the stomach. If solid, it has to undergo the preliminary process of mastication. During mastication it is freely mixed with the alkaline saliva, which is poured out in abundance from the salivary glands, and which much facilitates the process. Liquid food passes into the stomach with comparatively little admixture of saliva. Solid food, on the contrary, whilst being ground and divided, is saturated with salivary secretion, which gradually forms it into a pulp fit for the action of the gastric juices. From the various experiments that have been performed, it would appear that the subsequent changes produced in solid food by the stomachal digestion are much facilitated by the presence of the saliva.

The saliva also appears to have a peculiar power of transforming the amydon or starch of farinaceous food into grape sugar, a necessary transformation in the series of food changes. This is the more remarkable as the gastric juices do not possess this power. They appear to act more especially as a solvent of the nitrogenous food element.

As soon as food reaches the stomach its presence determines the secretion of the gastric juice, which is not found in that organ during the period of vacuity or repose. This secretion exercises a very peculiar dissolving power over the food which is submitted to its action, gradually reducing it to the condition of a grey creamy or pultaceous fluid. The time employed to effect this dissolution varies according to the nature of the food; animal substances, as a rule, taking longer to digest than vegetable.

The period of stomachal digestion is one of great vital activity for that organ. The contact of food with the coats of the stomach is immediately attended with an influx of blood to its mucous membrane, which becomes highly vascularized. In this mucous membrane are innumerable glands, imbedded as it were in longitudinal bundles in its tissue, with their orifices opening on its surface. These minute glands secrete the gastric juice, which they accomplish by the successive formation and rupture of the cells that contain it. The muscular structures of the stomach are at the same time contracting actively, so as to bring successively each portion of the food in contact with the mucous membrane from which gastric juice is pouring uninterruptedly: these contractions also carry off, towards

the pylorus and intestines, that portion which has been dissolved and elaborated.

The gastric juice is acid, a property it owes to its containing lactic or hydrochloric acids, and the superphosphate of lime. Its digestive properties depend on a peculiar animal matter, to which the name of pepsine has been given, and which may be extracted in the shape of an amorphous powder. A solution of pepsine will dissolve meat or any other alimentary substance at a temperature similar to that of the body.

When empty the stomach, which may be termed in some senses a large muscle, contracts on itself; when it contains solid food it contracts firmly on the food, and forces it round and round the large curvature of the stomach, and then back to the œsophagiac orifice by which it entered. As the food dissolves and assumes the character of a creamy pultaceous fluid, which is termed chyme, it escapes from the above-described circuit, is directed towards the pylorus, and passes into the intestines. Fluids are, in a great measure, directly absorbed by the walls of the stomach, which sift out and retain their solid constituents.

The time employed by the stomach in thus digesting or dissolving food varies according to its nature,

and according to the individual. Various means have been resorted to with a view to solve this question: animals have been killed at different hours after the ingestion of food; food has been placed in hollow perforated balls and tied to a string, by means of which they could be withdrawn at any time; or vomiting has been artificially induced. The most conclusive experiments, however, were those of Dr. Beaumont, of New York, on a young Canadian, which have been quoted by all recent physiologists. Dr. Beaumont's patient, a healthy young man, had received a gunshot wound just over the stomach, which exposed and opened that organ. The wound, on healing, left a wide fistulous perforation, which had to be closed artificially. On removing the plug or artificial covering the food could, at any period of digestion, be removed and examined, and the state of the stomach and of its secretions could be investigated.

Dr. Beaumont went through a very extended series of observations with his patient, and came to the conclusion that cooked vegetables and fluid animal substances were easier and sooner digested than flesh; and that the comparative rapidity of the digestive process depends principally on the degree of cohesion of the tissues exposed to it, that

is, on their tenderness or toughness. According to the table published by Dr. Beaumont, the following were the principal results noticed:—rice and tripe were digested or chymified in an hour; eggs, salmon, trout, apples, and venison, were digested in an hour and a half; tapioca, barley, milk, liver, fish, in two hours; turkey, lamb, potatoes, in two hours and a half; fowls, beef, and mutton, in three hours and a half; veal in four hours. The same results were obtained on macerating these substances in the man's gastric juice, out of the stomach. The results obtained by other observers have varied, more or less, according, no doubt, to individual idiosyncrasy or peculiarities, and to the state of health at the time of the experiments. From my own experiments and observation, principally directed to the state of the urine after food, I think I am warranted in giving the following list as a guide to be generally relied on in estimating the comparative digestibility of different articles of food: milk, eggs, broths, and light soups, cooked vegetables, fish, fowl, game, lamb, mutton, veal, beef, salted meat, including ham and bacon. The time occupied in the digestion of these alimentary substances, before they reach the blood, and modify the urine, varies from two hours for the lighter food—eggs, milk, broths,

&c., to five hours for the more dense alimentary substances, and more especially for salted meats, ham, beef, bacon, &c.

The chemical changes that take place in the stomach are important. The fibrin and the albumen of animal tissues and fluids are chemically acted upon by the gastric juice, and appear to be converted into a low form of albumen, from which they are later to be again elaborated. The same change probably takes place in the nitrogenous elements of vegetable food. The other elements of vegetable substances are principally sugar, gum, lignin, and amydon, or starch. The sugar, gum, and part of the lignin, which are soluble, are probably dissolved at once, and absorbed; whilst the insoluble starch that has not been converted into dextrine or sugar in the stomach, probably undergoes that transformation in the duodenum under the influence of the pancreatic secretion. The action of heat in cooking expands and breaks the starch granules, thus rendering them more easily acted upon.

The oleaginous elements, including all oils, fats, butter, &c., are not chemically modified by the stomachal digestion; they are merely separated and reduced to a minute state of division.

On leaving the stomach, the chyme becomes

mixed with the seeretions of thc panercas and of thc numerous minute glands which are situated in the mueous membrane of thc small intestines. The seeretion of the panereas, a gland of eonsiderable size, is abundant, and presents the same physieal propertics and chemical eomposition as the saliva. It appears dcstined to perform in part the same office, as it also possesses the power of transforming into dextrine and sugar granules of stareh that have escaped the action of the saliva in the mouth or in the stomach. It is also supposed that one of its officcs is to prepare fatty principles for easier absorption, by transforming them into fatty aeids and glycerine.

The duet from the pancreas often opens into the intcstines by a joint canal with that from the livcr, and when this is not the case the two duets are in elose proximity. Thus these two secretions mingle, and it is probable that thc result of their union is a compound secretion possessed of peeuliar properties for promoting the digestive elaboration of the ehyme and preparing it for absorption by the lactcals.

The liver is a large gland, thc secretion of whieh, bile, is vcry abundant. The amount of bile seereted in the twenty-four hours is variously calculated to be from half a pint to two or even three pints. The secrction is retarded during fasting, and aeeeleratcd by the

ingestion of food. From the numerous and important physiological researches that have been made in modern times, it appears that the biliary secretion has a double function to perform. On the one hand it purifies the blood of carbon, the product of molecular disintegration, or a component of imperfectly digested and unassimilated chyle; and on the other it performs an important part in the digestive process.

Bile is principally composed of carbon and hydrogen, which it separates from the portal blood, loaded as that blood is with albuminous and amylaceous products directly absorbed from the food in the intestines. Thus the portal blood is purified by a process which we may partly compare with respiration; which, under certain circumstances, it may partly or wholly replace. In respiration the carbon and hydrogen in excess in the venous blood combine with the oxygen of the atmosphere, and form carbonic acid and water.

In the liver the carbon and hydrogen of the portal blood are merely transformed by the secretive process into bile. In both cases, however, the venous blood is purified. During fœtal life the purification of the blood appears to be entrusted to the liver only, and on birth the intestinal canal is found filled with bile in the shape of meconium. In warm climates,

and even in temperate climates, when the weather is warm, respiration is less active, and consequently less efficient in purifying the blood of its carbon and hydrogen. As a compensation the secretory activity of the liver increases, and hence, partly, the frequency of liver disease in these climates and seasons.

During digestion, bile, which thus flows into the small intestine along with the pancreatic fluid, mixes with the chyme shortly after it has passed out of the stomach. This mixture of the bile with the chyme no doubt modifies its character, and fits it still further for its absorption by the lacteals. It operates also as a stimulus on the entire intestinal canal, promoting its action and the excretion of the residue of the food, as shown by the constipation which accompanies jaundice, when the excretion is temporarily arrested; and the diarrhœa which follows bilious fluxes. It is worthy of remark, however, that in health the greater part of the bile is reabsorbed in the intestinal canal, not more than one-sixteenth passing away with the motions.

The chyme, or food which has undergone the stomachal digestion, becomes alkaline, instead of acid, after mixing with the pancreatic and biliary secretions; it is, also, more homogeneous, more consistent, and darker in colour. Thus elaborated,

it has become fit for the absorbent process which now commences. The soluble portions of the chyme are successively presented to the surface of the small intestine as it is propelled along its course, and are absorbed principally by the lacteals, but also partly by the veins. The lacteals are very numerous in the small intestine, and more sparse in the large. By this process the albuminous, fatty, and saccharine elements are taken up, as also the bile and the salts in part. What remains and is expelled from the body, as fæces, consists, or ought to consist, only of the non-nutritive part of the food, viz. woody fibre, vegetable and animal epidermic detritus, mucous corpuscles, colouring matter of the bile, fat, starch unmodified by the digestive process, salts, &c.

The chyle which at first fills the lacteals presents the appearance of a milky fluid. This appearance it owes to the fatty globules, in a minute state of division, which it contains. These globules are supposed to be surrounded with albumen, which prevents their coalescing. The fluid in which they swim contains albumen in solution. After it has passed through the ganglia to which the lacteals converge, this fluid presents corpuscles similar in form to those of the blood, to which the name of chyle corpuscles

is given. Fibrin is also found in the chyle, which has evidently been formed out of the albumen of the chyle. The chyle corpuscles become more and more perfect, and more like true blood corpuscles as the chyle advances towards its destination, the jugular vein; until in the upper portion of the thoracic duct, they often assume the red colour of the latter. The fibrin also increases in quantity in the same proportion. Thus the more the chyle, the result of the digestive process, approaches the point at which it is thrown into the current of circulation, the more it assumes both the microscopic and chemical characteristics of the blood, which it is evidently destined to renew.

By this same channel, the thoracic duct, is also thrown into the current of circulation the fluid collected by the lymphatic vessels from all parts of the body. These vessels, originating in nearly all parts of the economy by minute radicules, pass through ganglia like the lacteals, and converging, finally terminate in the thoracic duct. They contain, at first, an albuminous fluid like the lacteals, but clear instead of milky, owing to the absence of the fatty particles. Lymph corpuscles and fibrin appear on their emerging from the ganglia, and both the perfection of the first, and the quantity of the latter

increase as they approach their termination. The lymphatics, like the lacteals, evidently perform an important part in the renewal of the blood; but, unlike the lacteals, the renovating elements they contain and elaborate are drawn, not from food, but from the blood itself, and the tissues it creates.

To complete this sketch of the sources from which the blood, the grand element of nutrition, is derived, we must not forget that, as we have seen, part of the chymous fluid is absorbed by the intestinal veins, and is carried directly by the portal vein to the liver, and that there it is elaborated and eliminated in the shape of bile; the greater portion of this bile being again absorbed in the small intestine.

Thus we find the chyle which enters into the circulation by passing from the thoracic duct into the jugular vein is, in reality, new blood. This new blood is elaborated out of the chyme and bile absorbed in the intestines and out of the fluid brought by the lymphatic vessels from the capillary tissues. The quantity of chyle thus contributed in the twenty-four hours is very considerable, amounting, it is supposed, to as much as one-third or one-fourth of the weight of the blood contained in the body. This fact proves how rapid and constant must be the

nutritive processes, for the weight of the blood of a healthy adult is supposed to be about twenty-eight pounds.

The new, or lacteo-lymphatic blood, reaches the right heart along with the venous blood, returning from the different parts of the body. It is propelled by the right ventricle into the lungs, and as it passes through the capillary vessels which form the connecting link between the pulmonary artery and vein, it comes in contact with the atmospheric air, introduced by respiration into the pulmonary cells, around which the capillaries in question are spread. It is at this stage of the pulmonary circulation that the chemical changes of respiration take place; changes which modify the air inspired on the one hand and the blood on the other.

The atmospheric air which enters the lung in inspiration is composed of 79 parts of oxygen and 21 of nitrogen in every hundred. It also contains carbonic acid in the proportion of about four volumes in 10,000, and watery vapour, with occasional traces of ammonia, &c. The air which is emitted from the lungs in expiration, has lost part of its oxygen, and has gained a considerable amount of carbonic acid and watery vapour; the nitrogen remaining the same.

The amount of carbonic acid thrown off is very considerable, amounting to about 160 grains per hour, or as much as eight ounces of carbon in the twenty-four hours. According to Liebig, the lungs and skin together would emit as much as 10·5 ounces during that time. The experiments which he and other observers have made prove that a considerable proportion of the carbonic acid eliminated by the blood, passes off through the skin. The skin thus becomes a species of respiratory organ, which greatly assists the lungs in purifying the venous blood of the surplus carbonic acid which it contains. Thence the evident necessity of keeping its pores open by frequent ablutions and by friction. In the lower tribes of animals, and especially in the Batrachia, such as frogs, toads, whose skin is thin and moist, life may be long supported by cutaneous respiration alone.

The carbonic acid thus evolved in respiration is to be attributed to the combination of the carbon of the blood with part of the oxygen, which disappears during respiration. This evolution of carbon from the lungs is necessary for the purification of the blood; and as it is retarded, indeed arrested to a great extent, by the presence of an undue proportion of carbonic acid in the air we breathe, the perni-

cious influence of an atmosphere loaded with this gas can be easily understood. Thus is explained in part the injurious effects of the atmosphere of crowded, badly ventilated, brilliantly lighted rooms.

Part only of the oxygen which disappears during respiration is consumed in the formation of carbonic acid. The number of cubic inches of carbonic acid exhaled in an hour being about 1345·3, the quantity of oxygen absorbed should be 1583·6. The surplus oxygen is generally supposed to be consumed in the more intimate or capillary structures of the body, and to combine on the one hand with the albumen which forms the new tissues, and on the other with the nitrogen of the decomposing nitrogenous tissues, and with the sulphur and phosphorus of the body, to form the sulphates and phosphates that are excreted in the urine.

It has been questioned whether nitrogen is exhaled or absorbed during respiration, and it appears probable that in very small proportions both conditions may be observed, exhalation, however, rather being the rule. Neither the absorption nor the exhalation of nitrogen, however, is sufficiently active or important to deserve taking into consideration in recalling the changes that occur in the nutritive fluid, the blood, during respiration.

It is worthy of notice that the air inhaled is always returned saturated with moisture, and that the quantity of watery vapour thus lost is considerable, amounting to from six to twenty-seven ounces, according to the hygrometric state of the air breathed. The dryer the air is the greater the amount of watery vapour thrown off to effect its saturation.

Respiration occasions great changes in the blood itself. It loses its dark crimson venous hue, and assumes the bright scarlet colour of arterial blood. Its temperature is raised; the quantity of oxygen which it contains is increased; that of carbonic acid and nitrogen is diminished; and the fibrin becomes more abundant; whence the greater coagulability of arterial blood.

It was formerly supposed that the oxygen of the atmosphere united directly with the carbon of the venous blood in the lungs to form carbonic acid, and that heat was thus generated. It has, however, more recently been proved that venous blood contains twenty-five per cent. of carbonic acid for twenty contained in arterial blood, whilst arterial blood contains ten per cent. of oxygen as compared with five per cent. contained in venous blood. Moreover, the heat of the blood in the lungs is scarcely, if at all, greater than that of other parts of the body, which would not

have been the case had the carbonic acid evolved in respiration been directly formed in the lungs, and had the latter organs been thus the focus and distributors of heat to the economy. From these well-established facts has been drawn the conclusion that the greater part of the carbonic acid evolved during respiration is not formed in the lungs, but merely thrown off by the venous blood during respiration. According to this view, the one now generally adopted, the carbonic acid is formed in the ultimate or elementary tissues of the economy by the union of the oxygen absorbed during respiration, and carried by the arterial blood to the capillaries, with the carbon resulting from the disintegration of these tissues, and also with the chyle-wafted carbon supplied by food and not converted into tissue. Simultaneously with this generation of carbonic acid, water is also formed by the union of part of the same oxygen with the hydrogen of the tissues and of the food elements. These chemical changes are attended with the evolution of heat, which is thus constantly emitted in every part of the body.

Whilst the oxygen absorbed by the arterial blood is thus combining with the carbon and hydrogen furnished by the disintegration of tissue, and by recently digested food, to form carbonie aeid and water, the

still more obscure and mysterious function of molecular nutrition is also taking place. The minute divisions of the systemic capillaries bring the arterial blood in connexion with the various structures which compose the economy, penetrating them in every sense, or spreading a network on their surface. These tissues have the vital power of selecting from the arterial blood, chyle renovated, the elements they require for their growth and for the repair of the waste that is constantly taking place in them.

Change, constant change, is the law of organic life. The molecular elements of the tissues of which the animal economy is composed are constantly dying, being resolved into their chemical elements, and are as constantly renewed: this renovation, this repair, takes place principally, as well as the original formation, out of the nitrogenous elements of the blood, the albumen and fibrin.

THE DESTINATION OF FOOD.

We have traced food through its various phases of elaboration up to its final destination. It was stated at first that articles of food may be divided into two great classes, the nitrogenous and the non-nitrogenous; that nitrogenous food is principally represented by animal substances, in which nitrogen is the prominent

element, whereas non-nitrogenous food is represented by vegetable substances, principally composed of carbon,—nitrogen being present only to a much more limited extent.

We have now arrived at the explanation of these facts, and find that the nitrogenous food is employed in repairing the wear and tear of our tissues,—in forming nitrogenous flesh compounds; whereas the carbonaceous or vegetable food furnishes nitrogen in small quantity only, and is principally employed in supplying materials for maintaining animal heat.

The organic changes that take place during nutrition,—during the formation and consolidation of tissues out of the blood, and during the disintegration of these same tissues,—are attended with the evolution of heat; but the heat thus produced is not alone sufficient to keep up the temperature of warm-blooded animals to their natural standard, surrounded as they usually are by a much lower temperature. To compensate, therefore, for the constant radiation and loss of heat, part of the chemical elements of the food consumed is burnt. The union of oxygen with carbon and hydrogen which thus constantly takes place in the animal economy is an example of combustion as perfect as that of the oil in a lamp, or as that of coal in a fire, and

is attended with the same evolution of heat. The only difference is, that with the lamp or fire the combustion is rapid, and attended with the evolution of light and flame; whereas, in the animal economy, it is slow, and unattended with these merely accessory phenomena; the heat is slowly and imperceptibly emitted. The slow combustion of the chyle-transformed carbonaceous elements of food probably commences as soon as the blood has become loaded with oxygen in passing through the lung, although the principal change no doubt takes place in the systemic capillaries.

In healthy digestion the chyle-transformed food, which is not employed in repairing the waste or increasing the volume of our tissues, and which is not burnt to produce heat, is probably eliminated by the kidneys, liver, and skin, in various forms of chemical combination, but principally in the shape of urea and bile. It may be presumed, also, that in a state of health, and under a properly regulated system of diet, the amount of chylified nutritive materials is not greater than the economy can dispose of in these, the legitimate physiological modes.

When the powers of the economy, however, are overtaxed by a greater amount of food supply and of chyle formation than can be thus disposed of, the

nitrogen in excess appears to be eliminated by the kidneys in the shape of a superabundance of urea, of uric acid, or urate of ammonia; the carbon in excess, by the deposit of fat in the tissues, or by a superabundant secretion of bile. The urea normally found, under all circumstances, in the urine, of which it may be termed the principal component, is no doubt principally the result of the normal wear and tear, or disintegration of tissue. Uric acid and urate of ammonia are also present in normal urine, but in minute proportion. Their presence in excess, as also that of urea, may be looked upon as the evidence either of an over-supply of nitrogenous food material or of diseased nutritive action.

In the process of normal nutrition, the different tissues of the economy have the power of extracting from the blood the various salts which they require. Thus it is that the bones and the brain extract the phosphate of lime which forms so important a part of their composition, and that other tissues select the salts which predominate in their structure. In each case the selection is made by their own inherent force of vitality. When these tissues have lived their time and are disintegrated, the chemical elements of which they are composed are thrown out of the economy to make way for new molecular formations;

The carbon and hydrogen, as we have seen, are mostly consumed in the production of heat, by their combination with oxygen to form carbonic acid and water. The carbon which has contributed to form the nitrogenous tissues is probably eliminated, in part at least, by the liver in the shape of bile.

The nitrogen is eliminated in the urine by the kidneys, the great nitrogen emunctories or purifiers of the blood. Whether healthy or morbid, the urine principally contains salts and nitrogenous products, such as creatinine, urea, and its compounds. The kidneys may be said to be large secreting filters, the object of which, in health, is to throw off the surplus fluids taken into the system, and to eliminate the soluble products of the disintegration of tissue. To the kidneys are also intrusted, as we have seen, the duty of eliminating from the blood the nitrogenous elements of food, imperfectly digested, imperfectly chylified, and, as such, unfit for assimilation. When we consider that all the blood in the body passes through the kidneys every few minutes, we shall better be able to appreciate the very great preservative powers which they exercise in this respect,—powers which are very generally overlooked, and to which we shall at a later period devote careful attention

FLUID FOOD, ITS ELABORATION AND DESTINATION.

We have said little as yet of beverages or of fluid food. Water, the basis of all, is composed of oxygen and hydrogen, and may no doubt be decomposed, and yield its elements to the animal economy in its passage through the system. It is probable, however, that to a great extent, it retains its chemical integrity during the different phases of its journey, and acts merely as a solvent. In this latter capacity it is all-important, holding in solution the solid components of the blood, contributing to form the tissues constructed by the molecular nutritive process, and again acting as the solvent of the used-up elements of our tissues on their disintegration and definitive elimination. Moreover, there is a constant demand on the part of the animal economy to supply various excretions and secretions. The lungs eliminate, during respiration, as we have seen, a considerable quantity of fluid daily. The same may be said of the skin, from which insensible perspiration is constantly carrying off vapour. Moreover, there are many glands, the lachrymal, the salivary, the intestinal, which make large demands on the system for water as the basis of their various secretions.

Water is contained in great abundance in all kinds

of solid food, but in much greater proportion in vegetable than in animal substance.

Thus water is abundantly introduced into the system whenever solid food is taken. The supply thence obtained is, however, quite insufficient for the wants of the economy,—a fact which explains the universal craving for fluid. The quantity of water required by the adult human economy has been calculated at about two pints during the twenty-four hours, independently of that which is contained in the solid food. This amount may be considered to represent the fluid requirements in cold or temperate weather. In warm weather, the insensible cutaneous exhalation is very sensibly increased, and the craving for fluid rises with the temperature. When the heat is very great, and approaches to or exceeds that of the body, the cutaneous exhalation and the desire for fluids are both extreme. Nature adopts this means of getting rid of the superfluous heat generated by the economy, which is no longer carried off by the cool circumambient atmosphere. The vaporization of the cutaneous perspiration on the surface of the body carries off, in a latent form, the extra heat, and keeps the body at its usual temperature. Thus is explained the relief which the free perspiration of a moist skin affords in warm weather, and the uncom-

fortable, burning sensation which attends dryness of the cutaneous surface under similar circumstances.

It is worthy of remark, that the absence of fluids is much more difficult to bear than that of solid food, so necessary is water for the vital processes. Life may be sustained for weeks without solid food, if fluid is supplied; but in the entire absence of the latter, death closes the scene in a few days. In a case of tetanic hysteria which I attended a few years ago, the patient, a young lady of eighteen, was at last seized with convulsive vomiting every time she attempted to take food. For five weeks she apparently rejected every particle of solid food that she endeavoured to swallow, and yet remained in the full possession of her faculties, although much emaciated. After that time, the vomiting extended to fluids, which she could previously swallow in small quantities, when she sank rapidly, dying on the fourth or fifth day.

The animal creation are satisfied with water; indeed they show dislike and repugnance to all other beverage. Man alone, especially in a civilized state, seeks to combine food and nervous stimulants with his beverage: the latter may thus be divided into nutritious or stimulating.

Nutritious beverages such as milk, soups, cocoa, &c., contain in solution the same elements of nutri-

tion as solid food, viz.:—saccharine, amylaceous, fatty, oily, and nitrogenous products. The watery element is absorbed by the coats of the stomach and intestines; whilst the solid substances, held in solution, remain behind, and are submitted to the digestive process we have already described.

Stimulating beverages are either alcoholic, as spirits, wine, beer, &c., or non-alcoholic, as tea, coffee, mathé, &c. The latter owe their stimulating powers to the presence of a peculiar element which has been extracted from tea and coffee, thein and caffein. This element produces all the stimulating effects of the containing beverages on the nervous system; it has, however, no chemical affinity with alcohol.

Alcohol is composed of carbon, hydrogen, and oxygen, the proportion of oxygen being comparatively small. This chemical composition points out its destination in the human economy. It is absorbed like water by the walls of the stomach and intestines, rapidly reaches the capillary vessels, stimulating in its course the liver, brain, and nervous system generally, and is in a great measure burnt by combining with its own oxygen, and with that absorbed during respiration. Thus carbonic acid and water are formed, and heat is of course evolved. The physiological

effects of alcohol, when introduced into the system, may be said to be stimulation of the nervous system, and combustion and elimination in the shape of carbonic acid and water, with evolution of heat, and the arrest or diminution of destructive metamorphosis.

Wine differs from spirits in containing less alcohol and more water, vegetable acids, and volatile ethers along with a vinous extractive principle, which have a separate stimulating power over the nervous system, independently of the alcohol.

The quantity of alcohol contained in wine varies, as will be seen by the following table:—

	Per centage of Alcohol.
Port	21 to 23
Sherry	15 — 25
Madeira	18 — 22
Marsala	14 — 21
Claret	9 — 15
Burgundy	7 — 13
Hock	8 — 13
Moselle	8 — 9
Champagne	5 — 15

The stimulating power of wine, however, is not to be measured by the mere amount of alcohol it contains. The volatile ethers and the extractive prin-

ciple participate in the stimulating influence which it exercises on the nervous system. For instance, Burgundy only contains from 7 to 13 per cent. of alcohol, whereas Claret contains 9 to 15 per cent., and yet, by most persons, the former is found to be fully as potent as the latter. This is probably to be explained by the greater predominance of the ethers and of the vinous extractive. In Champagne, this fact is still more apparent.

All wines contain vegetable acids free, viz. acetic, tartaric, and racemic acids. The proportions in which they are found are considerable, as will be seen by the following table, by Professor Mulder:—

	Grains in 100 grammes, or $3\frac{1}{2}$ ounces.
Hock	$8\frac{2}{5}$
Burgundy	$8\frac{3}{10}$
Madeira	$7\frac{3}{10}$
Bordeaux	$7\frac{3}{10}$
Champagne	$7\frac{3}{10}$
Lacryma Christi	7
Port	$5\frac{4}{5}$
Sauterne	$4\frac{1}{2}$

The presence of these acids is more or less apparent according to the amount of sugar which the wine contains. Thus, Sauterne, being all but completely

free from sugar, has a decided acid taste, although containing less acid than Port. This latter wine, so generally considered to be free from acidity, contains nearly six grains per ounce; but it also contains twenty grains of sugar per ounce, which obscures the acid. In Champagne the quantity of sugar is so great, that not only is its acid obscured, but sweetness is substituted.

The quantity of acid contained in the wines usually drunk in this country will be better appreciated when it is recollected that in a pint of Port there is sixty grains of free acid; in the same quantity of Champagne, Madeira, and Claret, eighty grains; and of Hock, one hundred grains. In this quantity of Port, Madeira, and Champagne, there is also, as we have seen, nearly an ounce of sugar.

Thus the stomach of wine-drinkers is called upon to dispose not only of diluted alcohol, but also of considerable quantities of free acids, sugar, volatile oils, etc., which form important elements to take into consideration—especially when wine is taken in large quantities. Is it surprising that, in such cases, it should so often disturb the digestive process?

Malt liquors, generally, differ from spirits and wine in containing, in addition to alcohol, a certain proportion of saccharine substance that has not been

transformed into alcohol during the process of fermentation, along with some soluble gluten derived from the grain.

By evaporation these elements can be obtained in the shape of a solid extract, which varies in quantity from four to eight or more pounds in the hundred of the beer. The gluten being the nitrogenous element in grain, and the sugar the carbonaceous, the well-known nourishing powers of beer are evidently dependent on their presence.

The alcohol contained in beer varies according to the kind of beer examined. In the stronger ales of our country, the proportion of alcohol is about the same as in the light continental wines, as will be seen by the following table:—

	Per-centage of Alcohol.
Small beer	1 to $2\frac{1}{2}$
Porter	$3\frac{1}{2}$ — $5\frac{1}{2}$
Brown stout	$5\frac{1}{2}$ — $6\frac{1}{2}$
Bitter and strong ales . .	$5\frac{1}{2}$ — 10

In conclusion, it must be borne in mind that the various functions and processes which we have rapidly analyzed, and which conjointly contribute to the nutrition and preservation of the human economy, are all under the influence of the nervous system. It

is through the influence of the brain and of the other nervous centres that the entire series of digestive and nutritive functions, as also all other functions, are carried on and efficiently performed. Thence the health and integrity of the nervous system, and, as a result, healthy nervous influence, are indispensably requisite for healthy nutrition.

CHAPTER II.

NUTRITION CONSIDERED GENERALLY.

In the preceding chapter, we have rapidly analyzed the various changes which food undergoes, from the time that it enters the animal economy until it has fulfilled its purposes, in repairing the wear and tear of the tissues, and in keeping up the animal heat. We are thus prepared to take a more general view of nutrition, and of the processes by which it is accomplished.

As we have seen, the various tissues which constitute the animal economy are ever in a state of change; for change, as we have said, is the law of organic life. When the molecules, by the aggregation of which our organs are formed, have lived a certain time,—probably a very limited one for most of the organic tissues,—they die, are disintegrated, taken up, and eliminated, to be replaced by others. This molecular death takes place, whether the organs into the structure of which they enter are called into

play or not. In addition to the slow changes inherent to organized life, we must also take into consideration the other more rapid structural changes which pertain to the functional activity of organs. Every muscle that contracts, every thought that passes through the brain, every sensation that is perceived, every secretion that occurs,—indeed, every organic action that is accomplished, — is probably attended with the destruction of the more intimate organic structures that have contracted, thought, been impressed, secreted, or acted.

Inasmuch as the health, vital power, and growth of an organ are promoted by the rapid succession of these molecular changes, it must become at once apparent that the exercise of any particular series of organs strengthens and invigorates them. Thus it is that general exercise develops the muscular system generally, and that the exercise of one particular set of muscles develops that set and not others; as is observed with the blacksmith or the dancer. With the first the arms, with the second the legs, attain unusual development, owing to the nutritive activity which is the result of their peculiar pursuits. Thus also it is that profound and continued study strengthens, invigorates, and enlarges the brain, increasing its nutritive and vital activity and power.

But in order that the different organs should be thus strengthened and invigorated by exereise, two eonditions are neeessary. Firstly, it must not be extreme,—it must not be earried so far that the vital powers are unable to repair the tissues as they are consumed or destroyed; seeondly, the elements of nutrition that are requisite to provide the materials of repair must be taken in suffieient quantity. If the destruetion of tissue from use is greater than the vital power of repair, loss of substanee follows. If the elements of nutrition are not duly supplied, the moleeules destroyed cannot be duly replaeed. In either ease, the destruetion or waste being greater than the renovation or repair, the organs, instead of being inereased, become atrophied,—diminish in bulk and power.

Thus we see that the eonstant but rational exereise of the museles renders a man more museular and vigorous; and as inereased museular vigour and power aetivates respiration, eireulation, and all the funetions of life, the physieal frame beeomes more perfeet, and the health sounder and more firmly established. On the other hand, eonstant exereise of the brain invigorates and sharpens the intelleet, and opens the mind to a world of thoughts and ideas to whieh the sluggish brain of the mere physieal man remains inaeeessible.

Throughout life, even when greatly prolonged, the same results are generally observed. The muscular man, who retains his active muscular habits up to old age, generally retains also unusual muscular vigour. Whilst the intellectual man, who has vitalized, vivified his brain by brain exercise or thought, generally retains great mental powers in advanced life. We see this fact exemplified in many existing celebrities, Humboldt, Lord Lyndhurst, Lord Brougham, Sir Benjamin Brodie, &c. We have seen it in many of the illustrious dead: Goethe died at 84,—Voltaire 86, Newton 85, Buffon 81, Franklin 84, Morgagni 89, and Rogers 94, &c.

Unfortunately, we rarely witness in the same individual a healthy frame developed by active exercise, combined with high intellectual power, the result of mental labour. Generally speaking, the muscular man, the rustic, or mere Nimrod, allows his mind to lie fallow; the molecular structure of the brain-substance is but slowly changed, and mental torpor and sluggishness creep over him, obscuring his mind in the mist of disuse. The student, the man of letters and thought, on the other hand, is apt to forget—to neglect exercise; for it requires time—much time,—which to him is all-valuable: time is more knowledge, more power; the means by which only he can attain the

object of his ambition. His muscles, but little used, left to their unstimulated organic changes, become weak and torpid. They promote but feebly respiration and circulation, and the activity of organic changes taking refuge in the brain, all other functions are languidly performed, and health becomes impaired, often irremediably.

The current of organic changes which constitute nutrition may, indeed, be compared to that of a river. The mountain stream, which descends precipitously from Alpine heights, is clear, transparent, and undefiled; because the watery atoms of which it is composed succeed each other so rapidly that no stagnation, no corruption, is possible. If dead leaves, stray fragments of wood, or decay in any shape, fall into it, they are hurried on, and do not contaminate its waters: it still remains the pure mountain torrent. Its sister in the plain, dragging her sluggish course through fertile prairies, with a scarcely perceptible current, is in a different condition. The leaves, the fragments of wood, the decay, that fall into her, remain where they fall, and gradually decomposing contaminate the surrounding waters. Such is life. The mountain stream is the organization in which all the organs, without exception, are actively exercised, in which the molecular disintegration and renovation

are constantly occurring, and in which, consequently, the phenomena of nutrition are vigorously and healthily taking place. In such an organization the vital power being necessarily strong, if the constitution be originally good, and surrounding circumstances are favourable, the ordinary causes of disease are victoriously resisted. The lowland stagnant stream is the organization in which the nutritive changes are slowly, sluggishly accomplished, in which the phenomena of molecular nutrition are feebly carried out, and in which, consequently, all morbific agencies have full scope for their development.

From what precedes, it will be at once evident that the nutritive requirements must vary greatly with reference to age, to social occupations and position, and to climate.

During the earlier periods of life, not only has the organization to repair the wear, the waste of tissues continually going on in the young as well as in the old, and to keep up its standard of heat, but it has also to build up the frame to the degree of development which it is destined to reach. This it does, as we have seen, by its own inherent vitality; each organ appropriating the additional nutriment it requires from the blood and gradually adding to its bulk. It

is, in a great measure, to meet this great demand, on the part of the economy, for the elements of nutrition that the young have such large appetites, such a power of rapid digestion, and that they consume such large quantities of food. The young of man, and of all animals, are also ever active, ever in motion; so that the waste, from use, must be great. The current of nutritive life, with children, is thus truly a rapid one.

A remarkable and important feature in the history of nutritive growth and nutritive repair of waste is, that as the organ grows and is repaired, it retains its primitive mould or shape. Although its molecules change, its form remains the same; the newly-added particles merely increasing the bulk in the one instance, and replacing the disintegrated molecules in the other. So thoroughly is this the case, that all the peculiarities of the body are faithfully reproduced, —even accidental ones, such as a scar or cicatrix.

CHAPTER III.

NUTRITIVE REQUIREMENTS IN MAN CONSIDERED WITH REFERENCE TO TEMPERATURE, CLIMATE, AND SOCIAL OCCUPATIONS.

THE nutritive requirements of the human economy are ever varying according to the circumstances in which it is placed, as regards temperature, climate, and social occupations. The materials or elements of nutrition made use of by the different races of men in different climates are, indeed, so variable, that were it not for the key afforded by their chemical composition, we should vainly endeavour to reconcile them.

We now know that the frame of man is composed of oxygen, nitrogen, carbon, and hydrogen, *plus* various salts; that the oxygen is extracted from the atmosphere during respiration; that the salts are provided for him in his food without his being aware of their presence, and that, after forming a part of his economy, they are eliminated also without his

cognizance. There remain, then, as elements of nutrition to be provided, nitrogen, carbon, and hydrogen. The nitrogen is required, as we have seen, solely to make and repair tissue; the carbon and hydrogen principally to create heat. The food of man must contain these three elements in a digestible form or he dies; either of exhaustion from waste and non-repair of tissue, or from cold, owing to the non-generation of heat; or from both causes combined, that is, from deficient nutrition.

All mankind require nitrogenized food to repair the daily waste of tissue; but the actual requirements of those who live an active, laborious, muscular life must be much greater than those of the indolent, who take little or no exercise, and scarcely use their muscular system. Nitrogen being most abundant in animalized substances generally, the food of those on whom laborious and continued muscular exertion devolves should contain such animal substances in abundance. Practically, we find that they consume it when they can. The navvie, the dock-labourer, the sportsman, eat considerable quantities of animal food, and, what is more, digest and assimilate it. The citizen who takes little or no exercise, and females generally, when not subjected to bodily labour, require less nitrogenous food; the

wear and tear of tissue being less with them. They consequently take less, as a general rule, unless actuated by the erroneous impression that in animal food lies strength, and that the more they take, the stronger they will become. From falling into this error, however, they often consume an amount of nitrogenous food which they can neither digest nor assimilate. It is the same with the indolent inhabitant of warm countries. Very little nitrogenous food suffices to repair the daily waste of an organization mostly at rest; for the mildness of the climate in which he lives greatly diminishes the necessity for constant labour which obtains under a more inclement sky.

The demand of the human economy for non-nitrogenous food, or food containing the materials required for the generation of animal heat, varies, also, considerably, according to climate and social occupations. We have seen that heat is generated, partly, by the combination of the oxygen taken up during respiration with the carbon and hydrogen of our own used-up, effete tissues, and partly by the combination of the said oxygen with the carbon and hydrogen of the food transformed into chyle by the process of digestion.

The standard heat of the human economy is

98° Fah., and varies but little at all ages and in all climates. When the external temperature is below 98°, the body is constantly losing heat by radiation. The lower the temperature of the circumambient atmosphere, and the more the body is exposed to its contact, the greater the loss, and the greater the amount of heat that has to be generated to keep up the normal standard.

When the temperature of the surrounding atmosphere is above 98°, the generation of animal heat must be at its lowest point, and the body, instead of parting with heat to the atmosphere, has to get rid of that which it creates in over-abundance, and to resist the heating influence from without. This it accomplishes, as we have already stated, by the vaporization of the cutaneous perspiration. When the latter passes from the fluid to the vapour state, a considerable amount of caloric becomes latent; and as this caloric is abstracted from the body, the latter is cooled down to the normal standard. The cutaneous perspiration, under such circumstances, becomes more or less abundant, according to the requirements of the system. As, however, it is only exceptionally that the human economy is called upon, in any climate, to bear a heat above 98° in the shade, the rule may be said to be, that we are constantly losing

caloric to the surrounding atmosphere, in greater or less degree, according to its temperature, and that a very considerable portion of the food which we consume—in our climate probably four-fifths—is destined to be burnt like coal in the fire, to replace the caloric so lost.

When the healthy animal economy has been exposed to a cold temperature for some time, the generation of heat by organic combustion becomes very active, and cold is borne without inconvenience. Should warmer weather suddenly occur, the generation of heat still goes on for a short time nearly at the usual rate, and the heat is felt to be very oppressive and disagreeable. The economy cannot all at once adapt its organic changes to the suddenly altered requirements. By degrees, however, it ceases to create heat in such abundance, and then, being no longer oppressed by that which we ourselves generate, we feel the heat less. Moreover, the skin becomes more and more fit to perform its new duties, and thereby to cool the heated frame.

The same series of organic changes occur conversely, and explain the apparent intensity of the first chills of autumn or winter. The economy for months has been creating but little heat, and some little time must elapse before it is up to the mark,—before it has

got up the steam, if we may use the expression. During that time, of course, we feel cold and chilly.

As we have seen, the heat-generating articles of food are those which contain carbon and hydrogen in great abundance, and little or no nitrogen; such as vegetables of all kinds, amylaceous or farinaceous substances, oils, fats, alcoholic beverages, &c. The natural instincts of man apprising him of the requirements of his economy, the colder the climate in which he lives, and the more he is exposed to atmospheric vicissitudes, the greater is his craving for heat-creating, nutritive materials, in the shape of carbonaceous food. Thus it is that the Esquimaux or Laplander is impelled to consume large quantities of oil, extracted from the seal and other northern animals, by the combustion of which in the penetralia of his economy he withstands the intense cold of his hyperborian home. Deprived as he is, by the rigour of the climate in which he lives, of vegetable and farinaceous articles of food, a bountiful Providence has provided him with a substitute in the oil-laden animals which surround him. By their nitrogenous flesh they renew the wear and tear of his nitrogenous tissues, and by their oily fat they enable him to create the heat he requires.

The inhabitants of all northern climates show the same partiality to animal fats, either as fat, suet, grease, or butter; thereby merely obeying the instinct which prompts them to seek for heat-creating articles of food. Nor is this instinct confined to the inhabitants of northern regions. In the South there is but little pasture; butter does not keep; and animal food and alcoholic beverages are but little required or consumed. Nature has, therefore, provided a substitute in the vegetable oils so abundantly supplied by the olive-tree, the palm-tree, and by other vegetable productions. The partiality evinced by the natives of southern regions for vegetable oil is evidently, in a great manner, the result of the instinct which prompts them to seek in their food the elements of combustion and of heat-production. This instinctive craving for oleaginous matter, evinced in all climates, is also connected with the physiological fact, on which more stress will be laid hereafter, that fatty matter is essential to the formation of healthy chyle.

The craving of the inhabitants of cold and temperate regions for alcoholic beverages is partly to be accounted for on the same grounds. Alcohol, being composed of carbon and hydrogen, feeds organic combustion, and thus creates heat. Alcohol, also, being directly absorbed by the walls of the stomach, very

rapidly reaches the circulation and capillary system, so that the generation of heat is very prompt. Thence, probably, in a measure, the sensation of general and genial warmth which soon follows the ingestion of all stimulating beverages that contain it. Thence, also, the power shown by the human economy in northern latitudes of bearing, without permanent injury, the habitual use of large quantities of alcohol in various forms. Thus, it is a matter of general observation, that a sportsman who in London can scarcely take a glass of whisky-and-water without suffering from headache and other disagreeable feelings, when shooting in the Highlands in Scotland, and exposed all day to the keen atmosphere and cooling breezes of this mountain region, will drink neat whisky with pleasure and impunity. Under such circumstances the respiration is more active, the air inhaled is denser, and more oxygen is absorbed in the lungs. The alcohol ingested is therefore readily decomposed, burnt, and heat is engendered to replace that which is being constantly lost by radiation.

In a more southern climate, or when leading a more sedentary life, this extra demand not existing, the alcohol imbibed is not got rid of so easily or so effectually; it is longer retained in the circulation, and thus stimulates the brain and nervous system

more powerfully. Moreover, its combustion interferes with the combustion of the disintegrated and effete tissues of the economy,—a most important fact in the history of alcoholic beverages,—and the pernicious results thus produced are increased by the physiological influence alcohol exercises in arresting the destructive metamorphosis of molecular tissue.

It will be remembered, that the organic disintegration of our tissues is followed by certain chemical changes. The nitrogenous detritus combines with part of the oxygen contained in the blood to form urea, which is eliminated by the kidney; whilst the carbon and hydrogen, combining with another portion of the blood-oxygen, form carbonic acid and water, which are thrown off from the lungs during expiration. If alcohol is present in the blood, its decomposition is so easily effected, and it combines so readily with the oxygen which the latter contains, that it appears, under ordinary circumstances, to be first burnt, and thus to interfere with the burning of the detritus of organic waste. Thence effete, used-up organic materials accumulate in the blood, which poison, as it were, the entire economy, helping to produce mental torpor and general nervous and organic disturbance. If we add to the above conditions the effect immediately produced on the brain by all

alcoholic beverages taken in excess, viz., first excitement and then stupor, we shall have a complete idea of the influence which they exercise on the human economy.

As nitrogen, carbon, and hydrogen are found both in animal and in vegetable food, man can live on either one or the other. A mixed diet, however, is evidently most conducive to his welfare, as it best enables him to meet the ever-varying demands upon his organization, for repair of waste, and for the generation of heat. The Esquimaux at the North Pole, and the Ranchero, or South American hunter, both live all but exclusively on animal food. But the Esquimaux feeds on animals loaded with fat or oil, which he consumes in large quantities, that he may, by the organic combustion of its carbon and hydrogen, create the heat he requires to resist intense cold. The South American, on the contrary, who is nearly always on horseback, and leads an active, muscle-consuming life, in a warm climate, feeds on beef dried in the sun, which affords him the nitrogen he requires to repair the waste of tissue consequent on his active habits. The dried beef, from which nearly all the fat has been removed, is sufficient for him, because the temperature of the surrounding atmosphere is constantly so high that little

animal heat is demanded, and consequently he requires but little carbon and hydrogen to create it, in the shape either of animal or vegetable food.

The Irishman and the Hindoo can live and thrive on a dietary almost entirely vegetable—the one on potatoes, the other on rice,—although inhabiting very different climates. But in both countries the amount of vegetable food required to sustain life is very great, especially in the colder climate. It is found that an Irishman wants many pounds' weight of potatoes, with milk, to keep him in health. The quantity of rice consumed by the Asiatic, although less in proportion, is also great. Potatoes and rice containing a much smaller proportion of nitrogen than wheaten flour, a very large quantity must necessarily be ingested, in order that the economy should extract the necessary amount of nitrogen which it requires to repair its waste. Thus, in both instances, the digestive system is loaded with a much larger amount of carbonaceous food than is demanded for the generation of heat by organic combustion. Were a small amount of animal food taken, instead of the superabundant farinacea, the true wants of the economy would be much better and easier supplied.

It is also worthy of remark, that the Irishman shows, like all Northerners, an ardent desire to

increase his heat-producing powers by the addition of whisky to his heat-producing food, which the Asiatic does not, because he inhabits a southern region. It would seem that the carbon and hydrogen contained in the food of the former scarcely sufficed for the constant generation of heat necessitated by a cold, damp atmosphere. Hence, in part, the instinctive desire for alcoholic beverages. I say in part, because the craving for alcohol, although it may have its origin in an instinctive feeling, is apt to degenerate into a habit and a vice, independently of the requirements of the economy, owing to the stimulating and pleasurable sensations which it creates.

The working of these physiological laws, by which the demand and supply of the repairing and combustible materials of nutrition are equalized, may be observed in the various grades of our own social fabric. Thus the railway workman, or navvy, and the Thames lightermen are subjected to severe and continued muscular labour, and constantly exposed to atmospheric vicissitudes. To meet the double expenditure of muscular structure or nitrogen, and of heat or carbon and hydrogen, they eat large quantities of meat, and drink large quantities of beer and porter, extracting the elements of muscular repair from the one, and those of heat-producing combustion from the

other. When some of these navigators were first taken to work on French railroads, it was found that they could do in the same time double the amount of work got through by the French workmen, who lived in a much more sparing manner, and principally on bread and vegetables. The French contractors were obliged, in order even partly to efface this difference, wounding to their national pride, very considerably to increase the dietary of their workmen, and more especially to nitrogenize or animalize it. By adopting this course, the French workmen very soon increased their muscular powers. The materials for greater muscular development being given, and the muscles at the same time freely exercised, the organic nutritive changes became more rapid, the muscles increased in compactness and volume, and the work-power increased in proportion. How great the difference between one of these large, powerful, muscular men, consuming large quantities of nitrogenous food, and burning a large amount of carbon and hydrogen, rapidly using and rapidly repairing his economy, and the thin, wiry Arab inhabitant of the Sahara desert, who lives on a few dates and a little camel milk! and yet each takes no more food than is required by his habits and by the climate in which he lives.

Once these fundamental physiological facts respecting nutrition are known and accepted, we are no longer guided by crude fancies, but have sound scientific data to lead us in regulating the diet of individuals and of communities. Indeed, the importance of a thorough acquaintance with these facts, both on the part of the medical profession and of the educated public, cannot be too highly estimated, as it will tend to dispel many fallacies, many erroneous ideas respecting food which have general currency. How few there are who know or bear in mind that a large proportion of the food we consume must be composed of carbon and hydrogen, and is merely burnt in the capillary tissues to create heat,—just as coal is burnt in a grate,—and that when food is denied, the sufferer dies of cold in our climate more than of nutritive exhaustion. How few there are who are aware that for nitrogenous food to really repair the waste of our tissues, all the various processes which constitute digestion must be fully and healthily carried out; and that the chyle, which is the result of these processes, if not perfectly elaborated, is in a great measure eliminated, thrown out of the economy.

The general impression, not only with the public, but with many members of the medical profession, appears to be that nitrogenous food and stimulants are

synonymous with assimilation and strength. The undeniable fact that between the two lies a gulf, occupied by all the varied digestive processes, the imperfection of any one of which neutralizes the result—healthy nutrition—is thus overlooked. Other grievous errors also are committed through the adoption of this, the popular view of nutrition. A certain amount of nitrogenous food is required to repair the wear and tear of the tissues, but more than the amount really demanded by organic nutritive activity, so far from adding to its power and energy, becomes a positive encumbrance—an actual poison.

In infancy and youth a considerable amount of food, and especially of nitrogenous food, is required. On the one hand, the entire economy is growing, increasing in bulk and in volume; on the other, the functions of life are all rapidly performed. The brain is active, ever acquiring information, ever full of thoughts. The muscles are constantly in play; a healthy child is ever in motion, unless asleep. Thus the tissues are constantly being worn out by use, disintegrated, and then renewed. Hence the large appetite of growing children; hence, also, their power of digesting great quantities of food. It may be remarked, that nature has provided for the young of warm-blooded animals, in the earliest period of

their existence, highly animalized food in the shape of milk. Milk, in many respects, is very similar to the blood. Its nitrogen is represented by the albumen and the casein, its carbon and hydrogen by the cream or butter. Thus milk contains within itself all the elements of nutrition; the nitrogenous elements for growth and repair of tissue, the carbonaceous for the generation of heat by organic combustion. Oviparous animals live on the contents of the egg in the first stage of their existence, which, like milk, contains within itself all the elements necessary for nutrition. In the egg, the white or albumen, represents the nitrogenous element; the yolk, the oily or carbonaceous.

When the growth of the body is completed, and the repair of waste, along with the generation of heat, have alone to be provided for, the appetite in health, if not pampered or viciously indulged, may be looked upon as the test of the economy's food-requirements.

The food-requirements of adult human beings vary, as we have seen, according to climate and temperature, and according to the activity of their organs; they also vary according to individual peculiarities. Some persons, even in health, digest rapidly and imperfectly the food which they consume. With them a considerable amount of it passes away undigested through

the intestinal canal, and escapes with the fæces. With them, therefore, the fæces, instead of being moderate in quantity, and merely containing the indigestible fibrous or ligneous tissue, epithelial scales, etc., are voluminous, and contain also farinaceous granules and muscular fibres unchanged, the result of the incomplete digestion of vegetable and animal food. With persons so constituted, hunger soon returns, owing to the demands of the economy having been imperfectly supplied, and a fresh supply of food is required. It is as if part of the coal placed on a fire had fallen through the grate. With others, on the contrary, the process of digestion is slow, and the elaboration of the nutritive materials contained in the food is complete. Such persons both require less food, and that food less frequently, inasmuch as they extract more nourishment from what they take.

Such being the case, it is evidently altogether impossible to lay down generally and *à priori* the amount of food that is required for the nutrition of individuals. The person who is protected against cold and atmospheric vicissitudes by warm clothing and a well-heated dwelling, and who takes little or no exercise, cannot, certainly, require the same amount of food—that is, of heat-generating, tissue-repairing material—as the one who is constantly exposed to

atmospheric influences, and who is constantly engaged in occupations requiring muscular exertion. Between these two extremes there are infinite gradations of social position, habits, and occupations, modifying the real food-requirements of the organization. Superadded to these considerations we have the individual peculiarities above described.

When dealing with masses, each placed in the same social hygienic position, as soldiers, sailors, the inmates of workhouses, and all aggregations of people living together, it becomes possible to establish a dietary in which the quantity of food required is determined. We must bear in mind, however, that even in these cases the quantities arrived at are merely true of the aggregate, and not of each individual that composes it. They are media obtained by acting on numbers. In such aggregations of individuals, some require more than the allowance, some less; but by barter or by gift the equilibrium is attained. Moreover, under such circumstances, the social and hygienic condition, the amount of exposure and muscular exertion, are pretty nearly the same for all.

For some years after the growth in height has been completed, the organs of which the human economy is composed continue to increase in bulk and in compactness, in a word, to become more per-

fect. The epoch of perfect development of the organization may be said to be attained by women at twenty-two or three, by men at twenty-four or five. For ten or twelve years after that, nutrition is in its full vigour, and thoroughly keeps up the integrity and energy of the organic structures. From thirty-five to forty it begins to flag, and the first appearances of decay or of want of nutritive power show themselves. The muscles, not being fully repaired, lose a little of their volume and power, and collapse; thence the wrinkles that begin to form in the skin, and which are more especially visible in the face, the skin of which is lined by subcutaneous muscles. Such is the origin of the "crow's feet," that form at the outer commissure of the eyes; often the first sad sign of departing youth. Such is the origin also of the lines and furrows that take the place of youth's dimples round the mouth.

All mankind would become thin and spare at this epoch of existence, were it not for a compensating fact. As a result, probably, of the diminished nutritive energy which we are describing, the carbonaceous elements of food are not entirely burnt by the oxygen of respiration, or eliminated by the liver, and fat is deposited in the laminæ of the cellular tissue, where it remains, it is presumed, in a state of organic

inactivity. This deposit of fat takes place all over the body, but more especially under the skin of the abdomen, hips, and neck. It stretches the yielding skin, and thus conceals the ravages of time, the results of diminishing nutritive power. To many women this change constitutes a second youth, and may even impart to them a charm and loveliness which they never presented in their earlier age.

The comeliness thus produced, however, like "all that is bright," soon fades. The deposit of fat often continues; especially when the tendency is constitutional, or the diet liberal, and the habits of life indolent. In such cases it may increase by degrees, until the abdomen becomes protuberant, the hips massive, and until the chin, neck, and shoulders blend into one. Then, indeed, not only has youth fled, but the grace and dignity of middle age has also departed. The adipose tendency may be arrested, no doubt, by exercise on the one hand, and by restraint in the quantity of food taken on the other; but how few there are who will acquiesce in such discipline! At this epoch of life, other evidences of diminished nutritive activity also begin to appear. Gouty disease shows itself, indicative of languid capillary circulation, and deficient elimination or combustion of effete organic detritus; atheromatous

deposits often take place in the arteries, the result of defective nutrition; and the veins frequently become weak, and subject to varicose enlargement. Later, as age advances, the nutritive power flags, and the decay is probably general; that is, takes place in all the various functions which constitute nutrition. Both the power of transforming and of elaborating food into chyle, and the organic and vital power of extracting the elements of repair from the blood, diminish in activity. Thence, although the aged often take as much food as the adult, they become thin, and waste in volume. In those in whom the tendency to the deposit of fat persists in old age, the waste of the organs is concealed by the layers of adipose substance which are formed underneath the skin, and which surround all the organs; but the shrinking and wasting of the muscles and of the other organs is not the less real.

As a necessary result of diminished digestive vitality, organic combustion languishes. Hence the chilliness of the aged, increased by the greater slowness of their circulation. The blood, circulating less rapidly through the lungs and the body generally, is less charged with oxygen; and the elements of combustion being less abundant, organic combustion takes place less rapidly, and less heat is generated. Thus is ex-

plained the cold hands and feet of the aged, and the necessity for artificial heat and warm clothing. Thence it is that the old man seeks the sun, and that we find him in the country sitting at his door for hours basking in the sun, seeking from its genial rays the warmth which the organic processes no longer afford, as in former days—the days of his youth and of his organic vigour.

As the current of human existence runs on, all these evidences of deficient nutritive power increase, and to them is often added the fatty degeneration of important organs; by which, if extreme, the thread of life may be brought to a close. The muscular powerlessness of old age is partly owing to diminished volume of the muscles, partly to the replacement of non-repaired muscular fibre by fat, and partly to weakened circulation and innervation. The loss of nervous power, and the weakening of the memory and of the intellect of the aged, is often attributable to fatty transformation. The wear and tear of the nervous substance of the brain is not effectually repaired, fat takes its place, and the powers of the nervous centre are for ever obscured.

At last nutrition ceases, and death ensues. The vital spark no longer vivifies the human clay, and its complex machinery is hushed for ever. Organic

repair has been brought abruptly to a close, the human fire is quenched, and heat no longer being generated, the body rapidly loses its calorie to the surrounding atmosphere; until, after a few hours, the marble cold of death has seized upon the tenement so long the abode of the organic processes we have described.

With those, however, who leave progeny, nutritive death can hardly be said to take place; their vitality survives in their children. The vital nutritive force which gradually built up the parent organization, repaired its waste, and enabled it to resist the destructive influences by which it was surrounded, is transferred in all its pristine vigour and freshness to its offspring: the latter grow and flourish, as the parents decay and perish. As with the animal, so with the vegetable world. All organized creations have the seeds of death in them from the first. In all, the nutritive force for a time is vigorous and energetic; powerful to produce and keep up the organized structure. In all, after a certain lapse of time, when reproduction has been accomplished, the vital power becomes less and less energetic. Finally, when decay has stamped its impress on the organization, has destroyed both beauty and usefulness, the nutritive force expires, and death ensues. Thus space is

made on the earth for the young, who unite the attributes which their parents have lost—beauty and power. Thus it is that the earth remains ever young and ever fair;—youthful and vigorous organizations ever replacing those which have fallen into decay and perished, through the weakening and final arrest of the original nutritive force.

NUTRITION IN ANIMALS.

Nutrition in animals follows precisely the same law as in man, with slight differences, deduced principally from the fact that man is omnivorous, whereas by far the larger proportion of animals are either herbivorous or carnivorous. That man is destined to live on a mixed dietary, partly animal, partly vegetable, is shown by his teeth, some of which resemble the teeth of the herbivorous animals, and some those of the carnivorous. It is also shown by his intestinal canal, which occupies a medium position, being neither as long nor as complex as that of herbivorous animals, nor as short as that of the carnivorous.

Herbivorous animals find in the grasses which they principally consume the chemical elements of nutrition, required for the nutritive growth and repair of their organization—viz., carbon, nitrogen, and hydrogen;

oxygen, as with man, being principally furnished by the atmosphere during respiration. Nitrogen is present in grasses in considerable proportion, and from it are the albumen and fibrin of the organic tissues generated. The carbon and hydrogen, which form the principal bulk of the vegetable food of the herbivora, are, on the one hand, converted into fat by the nutritive process, and on the other, are burnt in creating animal heat, as in man.

From these facts we might conclude that, for herbivorous animals to thrive and do well, a large amount of vegetable food must be consumed. And such is really the case, herbivorous animals requiring a large bulk and weight of the substances on which they live, in order that they may find in it enough nitrogen to form their often huge frames, and enough carbon and hydrogen to produce, by its combustion, the heat they require to make good the constant loss from exposure to atmospheric influences. The generation of heat, from organic combustion, must, indeed, be very great and powerful, when we consider how well they bear exposure to cold, night and day, and that often during very rigorous weather.

Carnivorous animals find the elements of nutrition already elaborated and prepared for them in the flesh

and fat of their victims. Consequently a less complex and shorter intestinal tube answers all the purposes of digestion. They have, as it were, merely to divide, macerate, and dissolve the nitrogenous tissues which they ingest, and to re-arrange them in their own economy, by the mysterious function of assimilation and organic nutrition.

NUTRITION IN PLANTS.

Nutrition in plants differs from nutrition in animals in the leading fact, that whereas the food of animals is principally derived from the organic world, that of plants is solely derived from the inorganic world.

All vegetable substances live and increase on food extracted from the soil or from the atmosphere, which their vital force enables them to decompose, if necessary, and to assimilate.

Plants, like animals, are formed of the elementary gases, hydrogen, oxygen, and nitrogen, of carbon, of sulphur, phosphorus, and of other inorganic elements, and salts.

By far the greater part of their bulk, however, is formed of carbon, which constitutes one-half of their weight in the dry state. It is principally extracted from the atmosphere, the carbonic acid of which is

absorbed by the leaves, the carbon retained, and the oxygen in great part emitted. The proportion of the other elementary components of vegetable substances, according to Professor Johnston, Agricultural Chemistry, are—

Oxygen rather more than one-third.
Hydrogen little more than 5 per cent.
Nitrogen from ½ to 4 per cent.
Sulphur 1 to 5 per cent.
Phosphorus about a thousandth part.

The following table, from the same source, gives a very clear idea of the proportions in which Nitrogen, Hydrogen, Oxygen, Carbon, and residual Ash enter into the composition of principal vegetable substances used as food. The figures apply to 1,000 lbs. of such substances, perfectly dry :—

	Nitr.	Hydr.	Oxy.	Carb.	Ash.
Wheat . . .	23	58	434	461	24
Oats	22	64	367	507	40
Red Clover Hay	21	50	378	474	77
Hay	15	50	387	458	90
Potatoes . . .	15	58	447	440	40
Oat Straw . .	4	54	390	501	51
Wheat Straw .	3½	53	389	48	70

The oxygen is partly derived directly from the atmosphere, and partly from the decomposition of

water, taken up by the roots, which also furnishes hydrogen. The nitrogen which plants contain, as in animals, is not supposed to be extracted directly from the atmosphere, but from ammonia, or from other soluble substances containing nitric acid, and taken up from the soil.

The sulphur, phosphorus, and other inorganic elements or salts which plants contain, are taken up directly from the soil by the roots.

Thus plants perform a double part on the surface of the globe. Firstly, by absorbing carbonic acid from the atmosphere, and fixing its carbon, whilst emitting its oxygen, they purify the atmosphere, contaminated by the respiration of animals and by combustion. Were it not for this agency of vegetable life, the atmosphere which surrounds the globe would probably, in the course of time, cease to be respirable both by men and by animals.

Secondly, they elaborate and prepare, in their own organizations, the elementary substances of the inorganic world, so as to render them fit to become the food of the animal creation. Such an intermediary is necessary, because the animals are not organized to extract the elements of nutrition, or food, directly from inorganic matter.

In addition to its utility, it is to the vegetable

world that the earth owes its beauty, its surpassing loveliness. Were it not for the plants which clothe it in verdure, the earth would be a mere barren rock, a mere cinder, a mass of scoriæ, such as our cold satellite, the atmosphereless moon, is supposed to be at the present day.

CHAPTER IV.

DEFECTIVE NUTRITION.

NUTRITION may be defective, either from deficient vital nutritive power, from the existence of acute disease, or from the imperfect performance of the processes which are concerned in the transformation of food.

DEFECTIVE NUTRITION FROM DEFICIENT VITAL POWER.

The transformation of food into chyle and tissue, and also the creation of animal heat by organic combustion, are vital functions which take place under the influence of the vital power transmitted by the parent to the offspring. If the parents are young and healthy, their nutritive power is vigorous, and in their offspring it will also, under favourable circumstances, be equally vigorous. Nutrition in the latter, therefore, will be perfectly performed, and a sound and healthy organization will be gradually created. It will have perfect vital power to repair

wear and tear, to create heat by the combustion of food, to resist the influence of perturbing causes, and to carry on with vigour the functions of life during the span allotted to the human race.

If, on the contrary, the parents, one or both, are themselves deficient in nutritive energy, or are weakened, debilitated by disease or by age, they endow their offspring with the fatal gift of their own defective vital energy. In such offspring the nutritive force being constitutionally deficient, it has not the power to form a strong and vigorous organization; so that the individual grows up small, puny in stature and development, wanting muscular strength and energy, and often, but not always, mentally deficient. The nutritive force may, in some cases, at first appear vigorous, and apparently form a healthy organization, but it flags and succumbs long before the period of its natural decay; and the death of the organization follows.

In either of the above instances, nutrition may take a morbid direction, the result of the taint or weakness transmitted from the progenitors. When this occurs, some morbid nutritive deposit, such as the tubercular formations of scrofula or consumption, may be generated, and threaten or destroy life.

This law, indeed, holds good throughout the

entire animal creation. The vital nutritive force may be originally deficient in power from the first, owing to its deficiency in the parents; and when such is the case, as a sequence, nutritive growth and formation are defective. This may even be the case although all the functions of digestion are satisfactorily carried out. Food may be properly digested and transformed into chyle, but either the tissues have not the inherent vital power of efficiently selecting and transforming into their substance the elements presented to them, or morbid products are formed. This species of defective nutrition is known by its results—an imperfectly formed and imperfectly renovated economy, or the formation of diseased structures.

In a medical sense, nature is regardless of individual life, but protects in every possible way the integrity and continuity of the species. All individuals who physically fall below the standard of normal healthy development are remorselessly removed,—in themselves or in their children,—to purify the race. On the other hand, the preservation and continuation of the race is provided for in the most stringent manner, being placed under the safeguard of the strongest of all passions, self-love and sexual love.

Thus it is that Providence secures the perpetuation of the human species in the full vigour and integrity of healthy development. Such a perpetuation is intrusted to the young, to the strong, and to the healthy, whose progeny are born with the seeds of life and health: the earth is to them and to their descendants The diseased and the aged merely prolong their own existence in that of their progeny for a limited space of time. They cannot endow them with the nutritive force which they do not possess, or which they have lost. Thus, their children are born with the seeds of disease and death in them: the earth is not to them, nor to their descendants.

DEFECTIVE NUTRITION FROM THE EXISTENCE OF ACUTE DISEASE.

In acute disease, the functions of nutrition are partially suspended, the digestive powers are weakened, or even for a time arrested; hence the loss of appetite or even the absolute loathing of food which ensues. The digestive organs being unable to transform and elaborate food, an all-wise Providence preserves them from the labour they are unequal to perform, by destroying the desire for nutriment, and rapid emaciation follows; the more rapid, the more complete the inability to digest food. The process of

organic destruction or disintegration inseparable from the use of our organs, and itself a condition of life, goes on, accelerated, perhaps, by the disease; but the materials to repair the loss not being afforded to the organization, it wastes in volume. Moreover, as the materials of organic combustion for the generation of heat are not elaborated by the digestive organs, the economy is obliged to re-absorb and consume its own fat—deposited, no doubt, in the cellular tissue partly as a kind of reserve tissue. Thus it is that after an acute illness of two or three weeks, the emaciation is often extreme, more especially when from the nature of the illness it has been impossible for the patient to digest any kind of food.

In continued fevers, in which the inability to take and to digest food is all but complete, and which may last for weeks, it is often found absolutely necessary to give considerable quantities of wine, or other alcoholic beverages, in order to afford to the organization the elements for heat-generation or organic combustion, and to retard the process of destructive metamorphosis of tissue. In the absence of such aid, the extremities, and then the body, gradually become colder, until death ensues, as much from cold as from starvation. In this case the human fire simply goes out for want of fuel; like a

coal or wood fire that has exhausted all the materials of which it is composed, and which expires for want of their renewal.

DEFECTIVE NUTRITION, FROM IMPERFECT DIGESTION AND ASSIMILATION.

The conditions which may render nutrition defective, independently of hereditary taint and of the presence of acute disease, in connexion with imperfect digestion and assimilation, are numerous. Among these conditions we may more especially mention, an insufficient supply of food calculated to minister to the wants of the economy; the abuse of alcoholic beverages; an over-supply of food; the sympathetic reaction on the stomach and on digestion of chronic disease situated in other parts of the economy; weakness, functional derangement, and disease of the organs to which are intrusted the elaboration and transformation of food.

DEFECTIVE NUTRITION FROM AN INSUFFICIENT SUPPLY OF FOOD.

The results which follow a deficiency in the amount of food ingested differ according as the deficiency bears on the nitrogenous or waste-repairing,

or on the carbonaceous or heat-producing food element,—or on both at the same time, as is usually the case.

If the nitrogenous element is deficient, the carbonaceous being abundant, the muscular and organic tissues are not properly repaired, for want of materials, and the individual becomes weak and liable to diseases of debility; and that although fat may be developed, and although he may remain apparently in good condition, retaining the outward appearance of health.

If the carbonaceous element is deficient, the nitrogenous being duly supplied, the materials of combustion not being afforded in sufficient quantity, chilliness and the sensation of cold is experienced. Moreover, the fat deposited in the various tissues and organs of the economy being sought out, and burnt to supply the deficiency of carbon, extreme leanness ensues.

The deficiency of one of the carbonaceous nutritive materials, the oleaginous, is attended with other pernicious results. It is now generally admitted, that oleaginous or fatty matter is absolutely required for the perfect and healthy elaboration of chyle. Throughout the lacteal system, but more especially in the lacteals which traverse the intestinal walls, the albumen in

solution is found in intimate union with oily matter. It seems to be combined with the extremely minute chyle-molecules. Observation appears to show that, for want of a due supply of this oily matter, the organic changes which the chyle has to pass through are imperfect, that nutrition suffers, and that disease, especially tubercular and scrofulous disease, is apt to supervene. On this physiological fact is founded the administration of cod-liver oil, in scrofula and in pulmonary consumption, both as a curative and as a preventive agent. These important facts respecting the primary nutritive processes have been fully elucidated by Professor Bennett, of Edinburgh, in his work on cod-liver oil, published in 1841.

The craving for oily matter is certainly one of the universal instincts of the human race, and is indulged in more or less in all climates: in the northern latitudes, animal oils are principally consumed; in southern latitudes, vegetable oils are in more request. It is probably one of the reasons of the craving of children in our climate for butter, which presents oily matter to the digestion in an easily assimilatable form, and is evidently a valuable dietetic agent.

It is worthy of remark, that the inhabitants of

Iceland, although living in a most unhygienic state, filthy in person and habits, and cooped up in badly ventilated huts, are said to be all but free from consumption and from other forms of tubercular disease. This fact is not improbably connected with their very great consumption of oil as an article of diet.

If the insufficiency of food bears both on the nitrogenous and on the carbonaceous element, the equilibrium between waste and repair is speedily lost, disintegration takes place more rapidly than reconstruction, for want of materials, and the body rapidly diminishes in volume. The rapidity with which the body thus wastes depends on the degree to which the food-deficiency extends, and on the circumstances in which the individual is placed, with reference to exertion, to organic expenditure, and to temperature. As the animal heat must be maintained by organic combustion, the greater the cold, the more speedy the emaciation, owing to the more rapid absorption of the fat dispersed throughout the economy. Thence it is, that in fevers and other maladies, in which the disease is prolonged for a considerable time, whilst but little food is taken into the economy, and that little imperfectly or not at all elaborated, emaciation is generally extreme when death ensues. Deprived of

nutritive materials, the body has actually consumed itself.

A given amount of nitrogenous food may be quite sufficient to supply the waste of tissues during inaction, but insufficient if muscular exertion be superadded. Unless the nitrogenous food be, therefore, increased, defective nutritive repair and loss of substance will ensue. This we see daily with horses. Whilst at rest, one or two feeds of corn will keep them in condition; but at work, we are obliged to give them four or five feeds, or they lose flesh and become emaciated.

In the same way a given amount of carbonaceous food may be quite sufficient to keep up the animal heat, if the individual is not exposed to atmospheric changes, if he is warmly clad, and lives in warm rooms. But if the same person is, on the contrary, exposed to cold and to atmospheric vicissitudes, if he is lightly clad, and has to resist these agencies without the assistance of artificial heat, he requires more carbonaceous food, viz. farinacea, fats, alcohol. If he does not obtain it, as occurred to our soldiers in the Crimea, heat is not generated in sufficient quantity in the capillaries; the extremities become cold, and if the exposure is continued they are easily frostbitten. Thence the lamentable frequency of frozen

extremities, *gelatio*, among our ill-clothed, half-fed soldiers. Their food was both insufficient in quantity, and deficient in the elements of nutritive repair and of organic combustion; so that it neither renewed the waste of tissue, nor afforded the necessary heat-generating materials.

In the higher classes of civilized society, artificial warmth and additional clothing are principally relied on to meet the additional requirements of the body in cold weather, and but little change is required or is made in the dietary. On the contrary, the working classes, exposed by their avocations to the weather, generally endeavour to increase their powers of generating heat, by increasing the quantity of alcoholic stimulants, and by additional food.

Thus we see that the dram-drinking propensity of these classes in northern and even temperate latitudes is merely the exaggeration of an instinctive want of the economy. This undeniable fact in physiology shows how vain is the endeavour to entirely eradicate the taste for stimulants in northern climates. All that the most sanguine can hope to effect is to prevent its degenerating into a national vice.

The ingestion of alcoholic stimulants of all kinds is attended with a feeling of temporary strength, and with pleasurable sensations, which may be partly attributed

to the genial warmth that they occasion all over the body, and partly to their direct stimulation of the nervous system. The natural tendency, therefore, with those who use them, if uncontrolled by reason and principle, is to recur to them again and again, as a source of physical strength, of warmth, and of mental pleasure and solace.

Thus it is that a soul and body-destroying vice may be contracted and cherished until it bears down all opposition; and until, through the ruin of the digestive and nutritive system, it brings on premature disease and death.

DEFECTIVE NUTRITION FROM THE ABUSE OF ALCOHOLIC BEVERAGES.

The mode in which alcoholic beverages, taken in excess, impair digestion and nutrition may be easily traced and demonstrated. As we have seen, alcoholic stimulants, in the shape of beer, wine, spirits, etc., may be ingested in moderation with positive advantage, especially in northern and temperate latitudes, by the healthy members of the community. By their stimulating influence on the nervous system of the stomach and intestines, they increase and promote the powers of digestion; and by the presence in the blood of the hydro-carbon of the alcohol, elements for heat-

generation are provided without the necessity of loading the stomach with as much hydro-carbonaceous food as would otherwise be required.

Moreover, the stimulus afforded to the general nervous system satisfies a craving for nervous stimulation, which all mankind exhibits at the adult period of life, and which may really be considered an instinct. In northern latitudes this instinct is gratified by the alcoholic, stimulating beverages in general use; whilst in tropical climates, where their heat-generating properties are not required, the craving is satisfied by the non-alcoholic stimulants, coffee, tea, mathé, tobacco, opium, etc. The fact is singular, but undeniable. There is scarcely a race or tribe under the sun that does not resort instinctively to some nervous stimulant, whereas the animal creation show no such taste—no such instinct. The cause is probably to be sought for in the much greater use made by man than by brutes of the nervous centres, and in the consequent greater exhaustion of nervous force. There can be no doubt that these agents, when taken in moderation, have the power of repairing the nervous energies, and we thus find that, throughout the world, the abstinence from one is made up by the use of another. In our own climate, for instance, those who abstain entirely from

alcoholic beverages, all but invariably fall back, with avidity, on coffee and tea, which supply them with the nervous stimulant they require.

When alcoholic beverages are taken in excess by healthy persons, and often when they are taken in moderation by persons suffering from disease or from disturbance of the digestive organs, the stimulating effect produced on the stomach is injurious, and the function of digestion is, consequently, improperly performed. The result is the generation of imperfectly elaborated chyle, unfit for the purposes of organic reconstruction. The most general evidence of perturbation of the digestion, caused by alcoholic beverages, is the presence in the urine of a person in whom it is usually healthy, *a few hours after the ingestion of food*, of uric acid, urate of ammonia, and of other morbid salts, such as oxalate of lime. Uric acid and oxalate of lime require the microscope to be detected, but urate of ammonia is readily distinguished, from its being precipitated by the urine as it cools, and thus rendering it turbid. The kidneys eliminate the imperfect chyle in this form, and thus accomplish one of their most important functions, that of emunctories, to which is principally entrusted the duty of removing from the circulating fluid effete unassimilatable nutritive elements. The

imperfect chyle is refused, as it were, by the structures it was intended to repair, and is elaborated and thrown out by the kidneys as noxious matter.

This over-stimulation of the digestive organs by alcoholic stimulants is often followed by irritation of the mucous membrane of the stomach, as is shown by the dry, hot state of the tongue the day after the excess; the tongue, it is well known, pretty faithfully indicating the condition of the stomachal mucous membrane.

The presence of alcohol in the circulation—for, as we have stated, it is directly absorbed as such by the blood-vessels of the stomach and bowels—is attended with important organic results. The vessels that principally absorb it are the portal veins, which ramify in the stomach and intestines. By their re-union they soon form the portal vein, which at once takes the alcohol-charged blood to the liver; and it is only after having passed through the capillary circulation of that organ, that it is poured into the general circulation.

Thus, after the stomach, the liver is the organ which most directly receives the influence of the alcohol ingested. Is it surprising, therefore, to find the liver often diseased in spirit-drinkers? The malady termed cirrhosis of the liver is generally

thus produced. Irritation is set up in the substance of the organ, lymph is effused between the lobules, which becomes organised and forms fibrous bands. These bands compress and partially obliterate the proper tissue which they surround, and thus produce partial or general atrophy of the liver. The passage of the portal blood through the organ being thereby impeded, serous or dropsical effusion takes place in the abdominal cavity, accompanied, in the course of time, by a complete break-down of the general health.

When alcohol in excess has entered the general current of circulation, as already stated, its ready combination with the oxygen of the blood, and its subsequent elimination by the lungs as carbonic acid and water, interfere with the functions which the blood-oxygen has to perform, viz., its combination with nitrogen to constitute the protein compounds which form the tissues, and its combination with the carbon and hydrogen of effete tissues and of the food, which it thus burns and eliminates from the economy. Moreover, it also exercises a direct influence in retarding molecular disintegration or the destructive metamorphosis of tissue. The consequence is, that the blood becomes loaded with effete nutritive elements, the result of imper-

fect chylification and nutrition, and of the non-elimination of the products of the vital disintegration of the tissues, among which *materies morbi* carbon occupies a prominent rank. The liver and skin, also emunctories for carbon, come to the assistance of the lungs; but in vain do they endeavour to purify the foul carbon-loaded blood, if the contamination is constantly renewed.

Were the necessary nutritive elements alone supplied, and the economy left to its own powers, in the absence of disease, and under favourable circumstances, the lungs, the liver, the kidneys, and the skin—the great purifiers of the blood—would generally restore it by degrees to a state of healthy purity. Indeed, this is what occurs in those who merely commit a temporary alcoholic excess. In the course of a few days, the blood is purified, local irritation subsides, and all returns to a natural state. But in the confirmed drinker, or in the individual who takes stimulants when, from digestive weakness or disease, or from other causes, they are decidedly prejudicial, the economy has not a chance. The organs enumerated, and especially the lungs and the liver, make vain efforts to purify the blood. Their efforts are constantly nullified by a fresh invasion of hydro-carbon in the

shape of beer, wine, or spirits; and these organs at last either become themselves the seat of actual disease, or suffer secondarily, from the inroads of disease in other parts of the economy

From what precedes it will be seen that it is by no means necessary that alcoholic stimulants be ingested in large quantities to do mischief, or to use the phrase already employed, to be taken in excess. If stimulants in any quantity, however small, interfere with the digestive and nutritive functions, they may be said to be taken in excess. Clinical experience has led me to the conclusion that they do so interfere whenever the digestion is sufficiently disturbed for the urine to be loaded with morbid salts, and more especially to be rendered turbid by the presence of uric acid and urate of ammonia, after the digestion of food. However weak the patient, I am persuaded that, as a general rule, no good can be derived from stimulants when this occurs. This clinical fact, as we shall see hereafter, is a most valuable guide in practice with reference to the administration of stimulants to the weak and to the dyspeptic.

DEFECTIVE NUTRITION FROM AN OVERSUPPLY OF FOOD.

Although at first the assertion may appear para-

doxical, yet the fact is probable that nearly as many human beings suffer in health and strength from taking too much food as from taking too little. To insure the preservation of the organization, an all-wise Providence has made the satisfaction of food-wants a pleasure; and thence the general tendency, when the supply of food is unlimited, to take more than is necessary,—to eat for the pleasure of eating.

As an illustration, we may point to the agricultural population, which, with a few exceptions, is the longest-lived section of the community; and yet how small the quantity of food on which they are obliged to live, even in our own favoured country! The father, mother, and children, in an agricultural labourer's home, have not only to live, but to pay all expenses with from ten to twelve or fourteen shillings a-week when in full work. A town tradesman and his wife will consume more than that, in positive food-value, on dinner alone; and many a dyspeptic invalid, wrapped up in woollen and silk, and kept warm by large fires, eats and drinks ten shillings' worth of food a-week before he or she reaches the dinner hour. As might be presumed from the marvellous provision with which compensating and equalizing conditions are provided in the animal economy to meet the sudden strains to which it may be subjected, the inges-

tion of an overplus of food is not necessarily injurious at the time. It either passes away undigested through the intestinal canal,—as probably occurs with voracious eaters,—or it is transformed into chyle as usual. In the latter case the overplus carbonaceous element is either deposited in the cellular tissue in the shape of fat, or burnt by its combination with oxygen, and excreted by the lungs and the skin, as carbonic acid, or eliminated by the liver as bile. The overplus nitrogenous element is excreted by the kidneys as creatine, urea, uric acid, or urate of ammonia.

Fat is an essential element of the human body, and has important uses to perform. It serves as a kind of soft mattress to the skin, which it lines everywhere, and as a cushion to many organs which are more or less imbedded in it. In the female it is much more freely developed than in the male, and by filling up the interstices of the organs gives to her form the graceful roundness which characterizes them. Fat once deposited in the meshes of the cellular tissue, its anatomical seat, is withdrawn to a great extent from the active current of organic life, and appears exempted from the rapid changes of disintegration and reconstruction which we have seen to obtain in other tissues.

The deposit of fat, either generally or locally, as

on the abdomen for instance, is generally the result of over-feeding. With some it is constitutional, and will take place even in early life on a very spare diet; in very many instances, the tendency shows itself in a very marked manner after the age of thirty-four or five; whilst with others it is the result of depraved and defective digestion.

Whatever the cause—be it over-feeding, constitutional predisposition, or defective nutritive power—the continued development of the adipose tendency is not unattended with danger. The individual whose economy has been invaded to any great extent by fat-deposits becomes obese, unwieldy, and unwilling to move. Indeed not only the will, but the power to take exercise fails. Some stones of abnormal fat have to be moved, carried by muscles themselves weakened through fatty deposit. The fat is at first merely deposited between the muscular fibres, giving them the streaked appearance and texture of fat meat; but as this condition of abnormal nutrition progresses, the fat actually breaks up the muscular fibre, and takes its place, thus giving rise to what is termed fatty degeneration. The same changes take place in the viscera. The heart, lungs, liver, bowels, &c., are at first merely oppressed, smothered as it were, by layers or cushions of fat which mechanically interfere

with their aetion; but later the fat deposit invades their strueture, whieh beeomes weakened, softened,—in a word, the seat of fatty degeneration.

These facts have reeently been admirably illustrated by Mr. Gant, in a work on prize eattle. In this interesting eontribution to seienee, Mr. Gant has proved that the animals, monstrously fattened, to whieh prizes are given at the eattle-show, are in reality mere speeimens of nutritive disease, and that very many of them are aetually suffering from organie maladies, the result of fatty degeneration of the tissues; and this at the very time they earry off the prize as speeimens of legitimate eattle-feeding. All Mr. Gant's arguments and illustrations are equally applieable to the human raee.

In all forms of abnormal fatty development, the only remedy, onee the tone of the digestive organs has been restored, is exereise and diet. If we are desirous to reduee fatty development or eorpulency, as much exereise should be taken as is eonsistent with strength and health, and a little less food should be ingested than is really required to satisfy the wants of the eeonomy. The way to aseertain the quantity of food thus required, and the only way, is to determine the aetual weight of the body every fortnight, and steadily to diminish the amount

of food ingested until there is a regular loss of, say, a pound monthly. A rapid diminution in weight might be followed by debility and weakness, the result of the partial starvation by which it is obtained. But a slow diminution such as described, obtained by exercise as well as by the reduction of food, is attended with no risk whatever.

By increasing the amount of exercise and exposure to atmospheric vicissitudes, organic expenditure or molecular disintegration is rendered more active. If the food-supply remains the same, the economy is obliged to re-absorb its own fat, to provide for the increased nutritive demand. If, on the other hand, in the absence of increased exercise and exposure, the amount of food is reduced below the nutritive requirements of the patient, the economy is obliged to call upon the fat in reserve to make up the deficiency, and the same result is obtained.

Very few, however, will consent to follow these rules, because they entail the sacrifice of appetites, and the exercise of self-denial. The generality of mankind, according to my experience, prefer to see "their shadow grow larger," with all the drawbacks thereto pertaining,—which are not few,—to vigorously applying the only real remedy.

The liver, as we have seen, also comes to the

rescue, and makes strenuous efforts to purify the blood of the carbonaceous nutritive materials, when they have neither been burnt by the oxygen of respiration, nor transformed into fat and deposited in the cellular tissue. Thence the frequent bilious attacks of large eaters, whose habits of life are not such as to enable them to assimilate legitimately the food they consume. The liver becomes loaded with bile, which is principally composed of carbon; and every now and then an explosion takes place, in the shape of bilious sickness and headache, or of bilious diarrhœa, or of some other form of biliary derangement.

The nitrogenous element of the chyle, when in excess, is eliminated, as we have stated, by the kidneys in the form of urea, uric acid, uriate of ammonia, and creatine.

Urea exists normally in the healthy urine in considerable amount, constituting a large per centage of its solid constituents. It is considered to be principally the product of the disintegration or destructive metamorphosis of the tissues, but it no doubt also represents, in part, the surplus nitrogenous elements of the chyle.

The quantitative amount of urea has been scrupulously examined in connexion with diet, and much valuable information has been obtained.

According to Golding Bird, the average amount of urea excreted by a healthy man is about 270 grains in the twenty-four hours. According to Lecanu, quoted by Dr. Carpenter, the mean amount is greater:—for a man 433 grains; for a woman, 295 grains; for a child of eight years, 207 grains; for old men, eighty-four or above, only 125 grains. The difference depends evidently on the variable activity of interstitial nutritive changes, rapid in the child, slow in the aged, more active in men than in women.

The quantity of urea contained in the urine increases with violent exercise; thus showing its dependence on muscular disintegration. It increases, also, if nitrogenous food is consumed in greater abundance than is required by the wants of the system; a fact which proves that the nitrogenous element of super-abundant food is also thus eliminated.

The formation of urea generally increases during the first stage of febrile disease, even when no food is taken, owing to the rapid destructive metamorphosis or waste of tissue which then takes place. If, however, the abstinence is prolonged, it diminishes. During convalescence, even when nitrogenous food is taken in abundance, the amount of urea is below the normal standard; owing, no doubt, to the nitrogen being employed in building up the wasted tissues, and to the

process of decay or disintegration being, for a time, carried on with diminished activity. It is asserted by Liebig that urea is not formed at once from the metamorphosis of tissue and from the blood, but from uric acid or creatine, by a process of oxidation. Golding Bird states, that the quantity of nitrogen excreted in the twenty-four hours in the form of urea represents five-sixths of the amount taken into the economy in the food.

Uric acid exists normally in the urine, but in much smaller proportion than urea. In health the 42 ounces of urine usually secreted in the twenty-four hours contain about 8·5 of uric acid, generally combined with ammonia and soda, in the shape of urate of ammonia and soda.

This combination insures the solution of the uric acid, one grain of urate of ammonia being soluble in 2570 grains of water or urine, whereas uric acid alone is only soluble in 8570 parts of fluid. If, however, the urine is very scanty and concentrated, and the external temperature much below that of the body, the necessary proportions no longer exist, and the urate of ammonia is precipitated. In this case the urine becomes cloudy until the urate of ammonia has collected at the bottom of the vase used.

When urate of ammonia is present in greater pro-

portions than those which the urine can normally hold in solution at a low temperature, it is always precipitated by the urine on cooling. This precipitation is of very frequent occurrence, a few hours after the ingestion of food, in the urine of the dyspeptic, and of those generally in whom the process of digestion has been imperfectly performed, from whatever cause. So constantly indeed do I observe it, that I have been led to look upon the presence of urate of ammonia, under these circumstances, as the indubitable proof that the meal preceding its appearance has been imperfectly digested.

In other words, I believe that in such cases the chyle itself has been defectively elaborated, and has proved unfit for assimilation. Thence its elimination, or at least the elimination of its nitrogenous element, by the kidneys, as urate of ammonia.

The above sketch of the various modes adopted by nature to get rid of a superabundance of food-material shows that overfeeding must necessarily be a much more baneful error than is generally supposed. If the digestive organs perform their duties and elaborate the chyle, the blood is overloaded with nutritive materials, which the lungs, the kidneys, and the liver have to dispose of as well as they can; these superabundant nutritive materials may thus become a

prolific source of capillary and systemic, as well as of liver, and kidney, and skin disturbance. If, on the contrary, the overloaded digestive organs succumb, and only imperfectly elaborate the chyle, the latter becomes a source of suffering to the entire economy, —a positive poison,—until it has been eliminated by the above-mentioned emunctories. Nutrition under such circumstances is necessarily defective throughout the organization.

DEFECTIVE NUTRITION FROM SYMPATHETIC REACTION ON THE DIGESTION, AND FROM FUNCTIONAL DERANGEMENT OR FROM ORGANIC DISEASE OF THE DIGESTIVE ORGANS.

The functions of digestion may be disturbed by the reaction of other diseases, as when they suffer sympathetically from the presence of brain or uterine affections.

They may also be disturbed by the existence of functional derangement of one or more of the organs by which digestion and nutritive assimilation are carried on.

Lastly, when the stomach, liver, pancreas, &c., are the seat of actual disease, modifying their organic structure, the processes of digestion are of course very imperfectly performed, and nutrition is in proportion perverted.

When the digestion of food is healthily and efficiently performed, the various changes which it undergoes occur without the individual having any consciousness of the operations that are taking place in his economy. He merely feels satisfied and well; his hunger is appeased, and his flagging strength is restored, even before the food has been digested and assimilated. The healthy chyle, having passed through the lacteals into the circulation, and having been vitalized by the oxygen absorbed in the lungs, affords to each tissue, to each organ, the nutritive materials which they require. Thus renovated, thus repaired, they are equal to the work that is required of them; no langour, no debility, is experienced. The brain acts vigorously, and the thoughts are formed clear and bright; the muscles contract with energy and freedom, and active muscular exertion is a positive want and a source of vivid enjoyment. Thence the sharp intellect and retentive memory of childhood; thence the constant desire for exercise, the unceasing gambols and gyrations of healthy early life. Sleep is, indeed, refreshing repose, which, closing the eyelids in a few minutes, leaves no scope for dreams or nightmares, and night appears but a fleeting oblivion. When the hours of darkness are over, and the brain awakes, the head is clear, the

mouth fresh and sweet, the tongue clean; all lassitude has disappeared; and the economy, refreshed and renovated, rouses itself ready for the labours and pleasures of the ensuing day.

How different the state of the dyspeptic,—of the one who, from whatever the cause, does not efficiently digest food. Defective digestion is occasionally unattended with pain, flatulence, or local disturbance of any description, and is only recognised by its results—general derangement of the health, and defective nutrition, as evidenced by emaciation or an unhealthy adipose state. Generally speaking, however, the defective digestion of food is accompanied by oppression at the pit of the stomach and in the chest, by flatulence, acid eructations, pain in the regions of the stomach, heart, and chest; by sensations of a foreign substance in the throat, leading to vain attempts to swallow; by nausea and sickness, dryness and bad taste in the mouth; by want of sleep, or by restless and unrefreshing sleep, disturbed by dreams and nightmare, and followed by a parched, white, and loaded tongue.

These symptoms are the evidences of defective digestion, and are, generally speaking, occasioned by the inefficiency of the stomachal digestion, the superabundance or morbid character of the gastric juices;

by the imperfect solution and chyme transformation of the food, by its fermentation in the stomach and intestines, or by the abnormal duration and laborious character of the stomachal digestion.

Once the chyle has entered the circulation and become a part of the blood, its imperfect elaboration and its unfitness for the purposes of nutrition give rise to a new train of symptoms. Instead of restoring and renovating the economy, it becomes, as we have repeatedly stated, a positive poison; and the blood, contaminated by the crude chyle, carries suffering to every region, from the crown of the head to the sole of the foot. Thence the headache, mental depression, and general lassitude. Moreover, as the tissues refuse nutritive materials, which are not fit for their use, the organic waste is not supplied, and sensations of sinking, of langour, and of faintness supervene, accompanied by a craving for more food, or for stimulants. If food is again given, as is usually the case, the craving is alleviated for an hour or two, the mere presence of food in the stomach having the singular power of appeasing the appeals of the body for nutritive materials. But the eventual result is the same; feeding a patient whose digestion is thus imperfect is repeating the never-ending task of the Danaïdes. As the patients often express it themselves, "their food does them no

good." The greater part of it merely passes through the economy, contaminating and poisoning it on its way, without serving the purposes for which it is taken.

I say the greater part, because, however defective digestion may be, a portion of the food ingested is so transformed as to answer the purposes of organic assimilation and combustion, or death would soon ensue. The relative proportion between the amount of food assimilated, and that which is rejected by the bowels and eliminated by the kidneys and liver, gives the degree to which normal nutrition is impaired. Thus in one person, the functions of digestion are merely slightly disturbed, there is only slight oppression and acidity after meals, slight headache and occasional sleeplessness; the urine is only exceptionally loaded with urate of ammonia after food, and nutrition does not visibly flag. There is no loss of flesh and no unnatural coldness of the extremities. It is, indeed, in such conditions of the digestive organs that a deposit of fat often takes place, and that there is, apparently, an increase in size and in comely roundness of form which is erroneously thought to be a proof of health. In such cases, part only of the chyle is removed by the kidneys and liver, as unfit for assimilation; and that which is retained for assimilation or combustion is even more than enough to satisfy the wants of the system.

In another person, on the contrary, the derangement of the digestive system is more decided, the symptoms which are thereby produced are more numerous and severe; a greater proportion of the food passes undigested through the intestinal canal, or is eliminated from the blood by the kidneys, in the shape of urate of ammonia or uric acid. The result is a deficiency of assimilatable material, defective organic nutrition, and progressive emaciation or wasting of the body.

In either case the assimilation or organic nutrition that does take place is not of a healthy nature; imperfectly elaborated chyle, destined to be in part thrown out of the economy as soon as it reaches the blood, is certainly not calculated to support healthy nutrition, nor does it. The organic tissues, thus built up from crude materials, contain within themselves the seeds of disease. Constitutional and hereditary taints are brought to light and developed, and chronic inflammations are set up; more especially in the liver and kidneys, which are, as we have seen, constantly at work to eliminate the food-poison.

URINARY DEPOSITS, IN DEFECTIVE DIGESTION AND NUTRITION.

In the preceding pages, I have repeatedly alluded to the presence of morbid salts in the urine, as a

result of imperfect digestion. I believe their presence to be the most delicate and most easily recognised test that we can bring to bear in the diagnosis of defective digestion, and I am also of opinion that its value, although recognised, has not yet been fully appreciated by the profession. Indeed, I believe that I am fully warranted in stating, that, practically, the very existence of the various morbid salts that are usually present, as a result of the imperfect digestion of food, is generally overlooked and neglected.

Healthy urine in man is of a bright amber colour, perfectly clear and transparent, and remains so on cooling, no deposit taking place. If allowed to cool in a wine-glass, a light floating cloud is generally observed floating in the centre or towards the lower part of the glass, which consists of mucus secreted by the mucus membrane of the urinary passages. The principal constituents of healthy urine are urea, uric acid, creatinine chloride of sodium, sulphates and phosphates, colouring matter and mucus.

Under the influence of defective conditions of digestion and nutrition, and under that of disease, the chemical composition of the urine is modified, and, on standing and cooling, morbid deposits take place. These deposits may, or may not, be accompanied by turbidity of the urine. They consist principally of

uric acid, urate of ammonia, purpurine or colouring matter, oxalate of lime, the triple phosphates, the neutral phosphate of lime, pus or blood globules, epithelial scales, and fibrinous casts of the uriniferous tubules of the kidney.

It is a popular notion, that mere cold renders the healthy urine turbid, but this is a fallacy. Healthy urine remains clear, however low the temperature, provided it only contains the normal proportion of uric acid in combination with ammonia, viz. 8·1 grains of uric acid for the 42 ounces of urine usually passed in the twenty-four hours. If the urine is more concentrated, or if the urate of ammonia is more abundant, although clear at the temperature of the blood, it becomes turbid from the deposit of urate of ammonia at a lower temperature. The precipitation of this salt, and the consequent turbidity of the urine, become more and more abundant as the thermometer falls. The general idea, that mere cold will cause its precipitation in healthy urine, is partly owing to this fact. When the temperature is above 50° or 60°, the urine may be loaded with the urate of ammonia, and yet little or no precipitation may take place; but if it should fall, from change of weather or from a diminution of the temperature of the room,—as in a bedroom in winter,—a copious deposit will occur. In

warm weather, to test for urate of ammonia, a bottle of the urine should be immersed in iced water.

The frequency of these deposits in cold weather may also be attributed, in some degree, to the action of cold interfering with the functions of the skin, arresting the cutaneous exhalation of effete nitrogenous matter, and throwing the onus of excretion on the kidneys; and also to its often rousing or increasing dyspeptic conditions, thus disturbing digestion.

These facts must be known and remembered, as the urate of ammonia deposit is the commonest of all, and is the one that principally gives rise to the turbid deposit so often observed in urine that has stood and cooled. Uric acid, oxalate of lime, and even phosphatic deposits, unless very abundant, by no means modify the physical aspect of the water to the same extent.

When investigating the nature and pathological importance of the morbid salts which constitute urinary deposits, the first point to ascertain is, whether the deposit is the result of defective digestion only, or of defective assimilation and disintegration or destructive metamorphosis of tissue. To accomplish this, the urine must be examined at different times, the greatest care being taken that the urine secreted subsequently to the process of the digestion

of food, and modified by the presence of recently formed chyle in the blood, should not be mixed with that secreted when the organic disintegration of tissue alone is taking place.

Thus, the urine should be examined a few hours after the ingestion of food, and especially of animal food, and also after a long fast, the first thing in the morning for instance. When the digestive functions only are impaired, the urine passed after food, the *urina digestionis*, although clear on being passed, will generally be found to become turbid on cooling, depositing an abundant precipitate of urate of ammonia, etc.; whilst that passed fasting, the *urina sanguinis*, will generally be found clear on cooling, and free from deposit.

For the experiment or investigation to be satisfactorily carried out, various conditions must be observed. The patient must not be suffering from any febrile disease, for, if so, the urine may deposit morbid salts at all times; partly from the imperfect elaboration of food, and partly also from modification in the mode of elimination of the elements of organic waste. Under such circumstances, uric acid and urate of ammonia are eliminated as well as urea, and in the place of urea. Sufficient time, also, must be allowed to pass for the processes of digestion to be accomplished

and for the chyle to reach the blood. As soon as the chyle has entered the circulation, the kidneys commence their function of filtration or elimination, if it is unfit for assimilation. This elimination they continue until the blood is thoroughly purified. Thus, for some hours after the ingestion of food by a dyspeptic patient, the urine will remain clear, because the chyle has not reached the circulating fluid. Then for a longer or shorter time it becomes turbid and throws down on cooling a deposit of a pinkish or pale hue, owing to its being loaded with urate of ammonia, uric acid, oxalate of lime, or phosphatic salts. After this, it again becomes clear, because the blood has been purified of the impure chyle and the urine has re-reverted to its normal character.

Such being the case, to test the digestion of food by the state of the urine, we must examine that which is secreted by the kidneys during the hour or two that follows the completion of digestion and the entrance of the chyle into the blood. This period varies, of course, according to the length of time that the food ingested takes to digest; which itself varies, as we have seen, according to the nature of the food and according to individual peculiarities. Milk, eggs, vegetables, fish, etc., take about two hours; so the urine should be examined about three hours after their

ingestion. Fowl, game, beef, veal, etc., take from two to three or four hours. Thence it is, respectively, from three to five hours after the ingestion of these articles of diet that the urine will be contaminated with the salts eliminated from the chyle they furnish to the blood. It is well, likewise, to make the patient empty the bladder two hours after the meal, to get rid of the fluids taken thereat, which, of course, first find their way to the bladder. Their presence may mar the experiment, as an excess of urine may so entirely dissolve the urate of ammonia, if not very abundant, that it is not thrown down by the cooled urine. With some persons the stomachal and intestinal digestion is so slow that a much longer time elapses before the chyle reaches the blood, and is thus abnormally eliminated by the kidneys. In others, the digestive processes, on the contrary, are very rapid, and the morbid deposits must be sought for at an earlier period.

Some precautions, also, are necessary with respect to the examination of the urine of the blood. Supposing the first morning urine is taken for that purpose, as is usually the case, we must take care that sufficient time elapses between the last meal, taken the day before, and the hour of retiring to rest, to allow of the elimination, through the kidneys, of the imperfectly

formed chyle. Otherwise, the morbid salts may continue to reach the bladder after the latter has been emptied at bedtime, and are consequently found in the urine passed on waking in the morning. Thus, if the dinner is at five or six, the bladder should be emptied between ten and eleven, or even later, and no other food should be taken. If the dinner is at two, the tea should be at six or seven; nothing very solid should be taken at the time, and it should be the last meal.

Even when all these rules are carefully observed, the urine of digestion and the urine of the blood in a dyspeptic patient may be both equally loaded with morbid salts, a condition which implies a very aggravated degree of defective nutrition. It implies not only that the digestion and assimilation of food is imperfect, but also that the organic decomposition, or metamorphosis and elimination of used-up molecular structure, is defective; and that, even in the absence of febrile excitement and disturbance. In such cases the entire series of nutritive processes are morbidly and inefficiently carried on, digestion, chylification, assimilation, and disintegration.

The urine may be very easily submitted to an analysis sufficient for all practical purposes. If it shows a strong acid reaction by reddening litmus paper,

the probability is, that the deposit is principally owing to urate of ammonia. This probability becomes a certainty, if we find that by heating the deposit over a spirit lamp in a test-tube the urine loses its turbidity and again becomes clear and transparent. If the turbidity were due to phosphatic salts, the deposit would remain turbid, disappearing, however, on the addition of an acid; and if to pus, a slight albuminous cloud would form and gradually collect at the bottom of the tube. Were albumen present, its solidification by heat would at once give a dense white albuminous cloud throughout the urine, which would also gradually collect at the bottom of the tube.

The microscope throws additional light on the nature of the turbid deposit by actually showing us of what it is composed. In the great majority of cases, it will be found to principally consist of urate of ammonia (Fig. 2), in the form of an amorphous deposit, which present the appearance of dust scattered over the field of vision, or aggregated in groups. In the midst are generally seen epithelial scales (Fig. 5), in more or less abundance, and sometimes fibrinous casts (Fig. 6) and fat or oil globules. Rhomboidal uric acid crystals (Fig. 1) are frequently found along with the urate of ammonia deposit. Brilliant octahedral crystals of oxalate of lime (Fig. 3),

sparkling like diamonds, are also not unfrequently observed. Crystals of the triple phosphates (Fig. 4) are frequently met with, but not as often as those of uric acid and urate of ammonia. Pus globules (Fig. 7) are occasionally present, alone or along with the crystals above enumerated. Turbidity of the urine, and the subsequent deposit, may be owing entirely to pus, in which case pus globules alone occupy the field of the microscope. Blood corpuscles (Fig. 8) are also seen in urine containing blood.

The information which the microscope thus throws on the nature of urinary deposits, and on their pathological importance, is invaluable, and can be replaced by no other means of investigation. A microscope of ordinary power, one that magnifies about three hundred times, is all that is wanted, and a practical acquaintance with the principal salts and morbid products which it reveals may be acquired in a few hours.

The presence of these morbid salts in the urine, when it is only observed after digestion, and merely for a limited time, may be considered to principally denote the existence of imperfectly-elaborated chyle in the blood; although it may also be the result of deficient vital assimilating or nutritive power. The kidneys are then acting the part of emunctories, of

filters, purifying the blood of chyle which is unfit for assimilation. When the urate of ammonia deposit is found in the urine at all times and seasons, independently of the digestion of food, it is, as has been stated, that a still more advanced state of defective nutrition exists. Not only is assimilation defective, but organic molecular disintegration, or the normal destructive metamorphosis of tissue, is also defectively carried on.

It is probably from the same cause that we find an abundant deposit of urate of ammonia taking place during the latter stage and the convalescence of fevers, and of various inflammatory diseases. The functions of nutrition have been thoroughly impaired, and the digestion of food has been all but at a standstill. The patient has been disintegrating his nitrogenous tissues without repairing them, and absorbing and burning his fat and carbonaceous tissues to keep up the organic combustion, or animal heat. Thence the blood is loaded with waste materials, imperfectly transformed, which are eliminated by the kidneys in the shape of an abundant urate of ammonia deposit.

The epithelial scales (Fig. 5), which nearly always accompany the urate of ammonia deposit, are thrown off by the mucous membrane lining the urinary passages. When very abundant, their presence may be considered

to be the result of irritation of the mucous surface, produced mechanically by the urate of ammonia. Some persons may have turbid urine from the habitual formation of urate of ammonia, etc. for many years without irritation of the urinary mucous membrane taking place. With others it occurs as soon as the lithatic urine is secreted by the kidneys, and is productive of much suffering, of pain in the region of the kidneys, darting along the ureters, and of dull aching sensations over the pubis in the region of the bladder. These symptoms are often accompanied by a constant desire to pass water, which rouses the patient several times in the night, and is not even fully relieved by emptying the bladder. I have met with some patients so sensitive in this respect, that even in health, if the ingestion of food is followed by the formation of urate of ammonia, they become aware of its presence as soon as the urine reaches the bladder, owing to the sudden pain it occasions. I have attended many patients suffering from irritable bladder from this cause, who had been erroneously thought to labour under stone, stricture of the urethra, or inflammation of the neck of the bladder.

Fibrinous casts (Fig. 6) of greater or less length, formed in the tubules of the kidney, are not unfre-

quently seen along with the epithelial scales and the morbid salts. They present, under the microscope, the appearance of hairs, and in them are sometimes entangled urate of ammonia, epithelial scales, pus or blood globules, and even crystals of oxalate of lime. Their presence is generally considered to indicate severe irritation or even disease of the kidney. I constantly find them, however, in simple cases of dyspepsia, in which the kidneys are evidently neither the seat of great irritation nor of actual disease.

When morbid deposits in the urine, the result of defective nutrition, are thus the cause of irritability of the urinary organs, it is in vain to hope for relief until the digestive functions have been restored to a more healthy state, and until the urine has ceased to be loaded with the lithatic salts. The latter keep up constant irritation in the bladder and urinary passages, in the same way as sand constantly thrown into the eye would keep up irritation or inflammation of the conjunctiva.

Uric acid crystals are found more or less abundantly under the same circumstances as the urate of ammonia, and in the same patients. I have in vain endeavoured to find a separate cause or reason for their presence in some cases, and their absence in others; as also for their appearance and disappearance in the

same person. I am, however, disposed to think that their constant existence indicates a more decidedly depraved state of the digestive functions, and a more debilitated, broken-down condition of the general health, than is shown by the presence of urate of ammonia alone.

I am disposed to think that the presence of uric acid and urate of ammonia in the urine, in such abnormal quantities as to constitute a deposit, is very much more frequently the result of defective digestion than of defective metamorphosis of tissue, at least in dyspeptic disease. That such is really the case appears to me evident, from the circumstance that I am able, in the majority of such cases, to trace them to the food ingested a few hours previously, and that they disappear from the urine secreted after a prolonged fast.

The oxalate of lime deposit has presented itself to me under the same circumstances as that of uric acid and urate of ammonia, and often in the same cases. The existence of oxalate of lime is supposed, by most writers, to be indicative of a peculiar diathesis, but my researches have failed to detect it in dyspeptic patients. Uric acid, urate of ammonia, and oxalate of lime, all appear to me, in them, to be indicative of the same organic states—viz., defective digestion, assimi-

lation, and disintegration, in a word, to be the result of what I have termed defective digestion and nutrition, and to answer the purpose of eliminating nitrogen from the economy.

Nitrogen is eliminated from the blood by the kidneys, in the form of creatine and creatinine, as well as in that of urea; but they are rarely met with in urinary deposits, however defective nutrition may be. But little practical advantage, therefore, can be derived from a knowledge of the fact.

The urate of ammonia deposit is nearly always coloured by the extractive colouring matter of the urine, to which the term purpurine is given. On its greater or less abundance in the urine depend the various shades of colour, from pale fawn to deep pink or brick hue, which these deposits present. Purpurine is a carbonaceous substance, containing as much as from 62 to 68 per cent. of carbon; and its presence in the urine is considered to indicate defective elimiaation of carbon by the usual carbon emunctories, the lungs, liver, and skin. Urate of ammonia, on depositing in cooled urine, has the peculiar power of causing its precipitation.

Thus, a very high-coloured urate of ammonia deposit not only implies a defect in the nitrogen supply, elaboration, and elimination, but also some defect in

the normal excretion of carbon, some arrest in the action of the lungs, liver, or skin, for which the kidneys are endeavouring to make amends.

The crystals of the triple phosphates and the amorphous deposit of the phosphate of lime are not so frequently met with in persons who are merely suffering from disturbed digestion and defective nutrition, as deposits of urate of ammonia, uric acid, and oxalate of lime. When the tendency to their formation exists, however, it appears to be connected with a much lower state of organic vitality, with a greater depression of nutritive power. Phosphatic deposits are principally observed in those persons in whom the nervous system has been too greatly and too continuously used, and the general vitality thereby lowered. When this is the case, there is of course a more rapid disintegration of the phosphatic salts which enter so largely into the structure of the brain and of the nervous centres generally. The acid phosphate of soda, which, by its reaction on the triple phosphate and the phosphate of lime in the healthy urine, secures its solution, is no longer in sufficient quantity to prevent the precipitation of the abnormally abundant phosphates, and they are thus more or less copiously deposited.

Phosphatic deposits are frequently observed in

eases of eerebral or spinal disease. They are considered to be due to the deeomposition of urea in the bladder, and to the union of its elements with those of water. Carbonate of ammonia is thus formed, and its base, by uniting with the normal aeid of the urine, preeipitates the phosphates. Chronie irritation of the bladder is often followed by the same results; the unhealthy mueus seereted by that organ aets as a ferment, and ehemieally modifies the eonstituents of the urine in the same manner.

The triple phosphate is at onee reeognised by its beautiful triangular prisms (see Fig. 4); but the phosphate of lime merely deposits as an amorphous powder. It may, however, be easily reeognised by its forming a eloud in the urine, even before it has eolleeted at the bottom of the glass as a deposit; by its resisting the aetion of heat, and by its disappearing under the influenee of an aeid poured in small quantity into the urine. If the tendeney to its deposit exists, it is often found in the urine passed a eouple of hours after breakfast, when a considerable quantity of bread has been eaten. Wheat-flour eontaining a large amount of phosphates, its origin in sueh eases is obvious.

Phosphatie deposits are frequently met with in the urine of divines, barristers, physieians, statesmen,

literary characters, and of those generally who use their brain to excess, when they are suffering from dyspepsia. Such a fact points to the absolute necessity of diminishing the headwork in the treatment of these cases.

The presence of pus globules is the undeniable evidence of inflammatory action in the urinary organs. If they are found constantly in the urine, they may be considered to be the result of inflammation of the mucous membrane of some region of the urinary system. If they are only found occasionally, and in large quantity, after attacks of pain and spasm in the region of the kidneys, we may conclude that an abscess, scrofulous or otherwise, has formed in the kidneys and burst into the calices. The presence of thousands of pus globules floating in the field of the microscope, and thus revealing what is taking place in the penetralia of the economy, is an admirable illustration of the light that the microscope throws on the subject of urinary deposits.

The existence of blood corpuscles is equally conclusive as to the presence of some internal source of hemorrhage.

The specific gravity of urine, loaded with urate of ammonia, is sensibly modified, and varies between 1020 and 1030. A higher degree of specific gravity

would, of course, render the existence of diabetes probable. In diabetic urine, however, the urate of ammonia deposit does not appear to take place. Nutrition is otherwise modified, and otherwise defective. For more extended details respecting urinary deposits, I must refer to the works which specially treat on the subject, and especially to that of the late Dr. Golding Bird. His "Treatise on Urinary Deposits" is a most luminous and valuable production. Most deeply is it to be regretted that this gifted physician should have been so early withdrawn from the scene of his labours.

In concluding this chapter, I must add that I am convinced, from my own experience, that it is utterly impossible to rationally regulate the all-important question of diet in ill-health and disease, without the information which can only be acquired by the examination of the urine and of its deposits. Divested of minute scientific development, that examination, as we have seen, is a most simple matter, and does not require any very extensive knowledge, either of chemistry or of the microscope. The greater the knowledge possessed, however, the more certain are the results obtained; and there is, therefore, every inducement to the student and to the practitioner to pursue their researches.

CHAPTER V.

PRACTICAL DEDUCTIONS.

In health and left to himself, man requires no rules to teach him how to select his food; an infallible instinct guides him to that which he requires to satisfy the wants of his organisation. His nitrogenous tissues grow and waste from use, and in order to afford them the necessary materials of growth and repair, he instinctively seeks and consumes nitrogenous aliments, flesh and other animal substances, and those vegetables which, like bread, contain nitrogen in the greatest abundance. His body is always, in all climes, in all seasons, at a temperature of 98°. To keep up this heat it requires fuel, carbon; so carbon is sought and consumed in the shape of vegetable substances, in that of oils and fats, and of alcoholic beverages. Instinctively, as we have seen, he increases the supply of the one or of the other, according as pursuits, position, or climate increase the organic demand for waste-

repairing or for heat-creating materials. The habit of self-indulgence, the idleness and want of occupation which attend upon ample means, or the desire to drown care, one or all often lead to the ingestion of more food and of more alcoholic stimulants than are required. But these deviations from the law of nature, from the instinct which prompts man only to take the kind and the amount of food that his economy requires, do not invalidate the rule; indeed they rather confirm it, inasmuch as such deviations are followed, all but invariably, by disease and by organic ruin.

Such being the case, healthy, rational individuals may safely, within the limits of moderation, follow the dictates of their own wants and tendencies with regard both to the quality and quantity of their food; as these tendencies may be said to interpret their instinctive organic requirements. Moreover, as I have already stated, food requirements and peculiarities vary, within such wide limits, in different individuals, that it is all but impossible to lay down any general rule.

In some persons the digestive process being very rapid, frequent meals are required, even when abundant. For want of food at comparatively short intervals, for instance, four or five hours, sensations of sinking and faintness come on, and if the desire for

aliment is not gratified, the appetite disappears, and general prostration, with headache, and even nausea ensue. Such persons are often large eaters, require much animal food, and probably do not thoroughly digest all they take; consequently the residue, or evacuations, with them are copious and voluminous.

In others, on the contrary, the digestive process appears to be very slow. When hunger has been appeased, the desire for food is long in again making itself felt. Such persons are generally satisfied with two or at the most three meals a day; they often are not large eaters, do not require so much animal food, and can bear, much better than the former, accidental or forced abstinence. It is to be presumed that they extract more completely the nutritive elements from the food ingested, and thence it is that they can thrive on less food, and can take it at longer intervals. As a necessary consequence, also, the food residue is less in volume and weight.

Dyspepsia frequently overtakes those who present this constitutional peculiarity. Their digestive powers unfit them for the food habits of those first described, which, unfortunately, they often adopt from imitation, social obligations, or medical precept. The result is that the digestive system, overpowered by an amount

of work which it cannot perform, at first rebels, and then deteriorates; dyspepsia, with all its horrors, becoming established.

Those who present this peculiarity of digestion have also much to suffer from the popular fallacy which represents the stomach as an organ that ought never to be empty during wakefulness. With very many persons it is a matter of creed that from early morn until late at night food should be taken every three or four hours, lest the stomach should remain empty, a state which is supposed to be attended with absolute danger to the organisation. Such fears, I need scarcely say, are perfectly groundless. The stomach is a mere instrument, an organic cooking apparatus, the office of which is to dissolve the food introduced into the system, and to prepare it, by the processes we have described, for the subsequent digestive stages. During the time it is so engaged, it labours very actively, secreting the gastric juice, and vigorously and incessantly contracting on the food it contains. Once, however, stomachal digestion is completed, and the chyme has passed the pylorus, as we have seen, all secretion ceases, the stomach closes on itself, and a period of perfect rest and quiescence ensues, which lasts until food is again introduced, when the "hard labour stage" again begins.

Thus, the object of the stomach-labour is merely to prepare the alimentary materials required by the economy at large. If these materials have been elaborated in sufficient quantity and in sufficient perfection to satisfy the wants of the system, the object is attained, the stomach has done its duty, fulfilled its mission, and until the materials it has elaborated have been consumed, or thereabouts, it has no function to perform, and is better empty than full. If left empty for a time, it rests, has leisure to recover its nervous, muscular, and organic power; to prepare itself, in a word, for the labours which the next meal will entail upon it. When, on the contrary, it is immediately refilled, its powers are again and again taxed, and unless they are equal to the labour imposed upon them, they flag, the gastric secretions become depraved, and digestion and nutrition are defective.

The powers of digestion, stomachal and intestinal, whatever they may be constitutionally, are greatly modified by the requirements of the organisation and by habit.

In childhood, when nutrition has not only to repair the wear and tear of tissue, but also to provide for increasing organic development, the digestive powers are very great, as evidenced by the proverbial hungryness of the young, and by their singular capacity for

disposing of large amounts of food. They are also remarkably powerful during the convalescence from acute disease, in the course of which there has been great organic waste, and consequent emaciation. For the time, the stomach becomes endowed with unusual energy and with never-flagging powers; until the organic loss has been repaired, wholly or in part, when the digestion resumes its wonted capabilities and peculiarities. The digestive powers also become very active when the economy has to make good and repair great and continued organic wear and tear occurring under circumstances favourable to health; as, for instance, during continuous and unusual bodily exertion, such as a shooting-excursion in a mountainous country.

In all these cases the increase in the organic activity and labour-power of the stomach, and of the other organs concerned in the elaboration of food, is the result of increased requirements on the part of the animal economy. It is an admirable illustration of the adaptation of means to the end in view, which we everywhere discover in nature.

The evidence of such nutritive requirements is to be found in the existence of sound healthy hunger. Hunger is the call of the organisation for waste-repairing, heat-producing, or nutritive materials.

When they become deficient, hunger, or the desire for food, is experienced. In health, the feeling of hunger is rather a pleasurable one; it is appeased at once by the ingestion of food, and when digestion is perfect does not return for several hours; in some, for many hours. In ill health, it is not so much hunger of this description that is experienced, as a languid craving for food, accompanied by sensations of sinking and pain at the pit of the stomach. These sensations are generally, not always, appeased by aliment, but they return with renewed force a short time after its ingestion. This return is due to the process of digestion having proved, in great measure, a deception, a delusion. Part of the food imperfectly dissolved by the gastric juice has passed through the bowels, part transformed into imperfect chyle, is in process of elimination by the kidneys and liver, and a small portion only has answered the nutritive purposes for which the food was ingested. Thence it is that the wantery of the organisation again makes itself heard.

Habits modify singularly the powers of the digestive system, and it is to this fact, in a great measure, that we must attribute the different food-customs of different nations. The human organisation in the early period of life is very elastic, and, provided the chemical materials of nutrition are regularly supplied

in sufficient abundance, it has the power of adapting itself to nearly any conceivable variation as to nutritive material, and as to hours of feeding. In this feature of his organisation, man illustrates the medium position which he occupies between herbivorous and carnivorous animals. The latter are mostly satisfied with one flesh meal in the twenty-four hours. The former, when grazing in a pasture, are feeding the greater part of the day. In the carnivora the flesh food is a ready-prepared nitrogen compound, which has merely, as it were, to be dissolved and transferred to the structure of the animal that consumes it, whereas in the herbivora a much more complicated digestive transformation has to take place. Moreover, a much larger amount of food is required, on account of the small quantity of nitrogen contained in vegetable substances. When man feeds on flesh, he approximates to the carnivorous animal, and requires less food and that less frequently than when he feeds on vegetable aliments.

Just as the stature, features, and bodily proportions assume a characteristic peculiarity in each individual during the period of growth, so the organic system also receives a stamp, the result of early habits, which usually lasts throughout life. The habits of organic life, if we may so term them, are particularly marked

in the digestive system. A man who has been brought up to the adult age on a very animalised dietary, in after-life requires such a dietary more than the one who has lived principally on vegetable food. Again, the one who has been accustomed until middle age to eat often may not, with comfort and advantage, be able to supply the wants of his system by two meals only. And yet this system of feeding may perfectly agree with his neighbour, early inured to it. Thus it is that the German, the Frenchman, and the Englishman become habituated to the food and food hours which obtain in their respective countries, and that their digestive powers often give way when they change their residence, and endeavour to conform to the novel habits of their new place of abode.

It is worthy of remark that a change in food habits is very much less likely to be injurious to health when it takes place in the sense of greater abstemiousness, than when it involves increase in the amount of food. There are few adults who have the command of food who do not take both more nitrogenous and more carbonaceous aliment than is strictly required; so that with the great majority there is a margin for retrenchment which may be infringed upon with impunity, and often with positive advantage.

Thus we see that, in health, man may, like the animal creation, safely consult his instinctive desires and early habits with regard to food requirements. His instinct will lead him to take that kind and that amount of food which his economy requires. As he can extract waste-repairing nitrogen from vegetables, and heat-creating carbon from the fat of animal tissues, he can live either on an animal or on a vegetable diet; or can, as he generally does, combine the two. He can also, by the compensating powers of his organisation, either extract a great deal of nutritive material from a little food, or a comparatively small amount of nutritive material from a great deal of food, and all without injury or suffering, provided the deficiency or superabundance of nutritive materials be not continuous. If they are, in the one case his body wastes and he becomes emaciated; in the other, in the course of time, disease generally supervenes.

In ill health, on the contrary, man loses, more or less, this marvellous power of nutritive adaptation. He can no longer trust to his secret instincts, which are in default; for hunger is absent, or if present, is morbid and depraved. In ill health, therefore, he must accept guidance, must become amenable to dietetic rules, and on their correctness depends his

safety. That the rules which must guide us in ill health should be founded on a knowledge of what occurs in health is self-evident; therefore we have now to see how the facts developed in the preceding pages apply to nutrition in ill health.

The popular idea with regard to food in ill health, that it is synonymous with strength, is, as I have endeavoured to show, a fallacy, a delusion. To imagine, as so many do, that to introduce large quantities of animal food into the stomach of persons who are weak through the reaction of local disease, or through functional disturbance, is necessarily to strengthen them, is not only contrary to physiological reasoning, but is contrary to facts: for such a course is seldom followed by any other result than by an increase of the nutritive mischief; the digestive powers become impaired, the food ingested is imperfectly elaborated and partly ejected, and nutrition flags.

Thence, in addition to the Protean ailments which accompany dyspepsia, we have increased weakness and debility, coldness of the extremities, and either a deposit of fat in the system, or emaciation. As nutrition becomes more and more defective the fat is absorbed, and emaciation become the rule.

When debility and loss of flesh are thus the results of defective digestion and assimilation, the plainest

common sense will tell us that it is not to be remedied by plying the patient with additional food, however nourishing (nitrogenous) that food may be. In vain do we increase the amount of the animal substances ingested, and give stimulants—wine, beer, cordials—if the stomach cannot properly transform what it receives. The only result is still further to oppress and fatigue it; to keep up irritation of the digestive system, should irritation exist; to increase the quantity of imperfectly elaborated chyle, which poisons the blood; and to tax still further the eliminating power of the kidneys, lungs, liver, and skin.

The common-sense course which we ought to follow when nutrition is thus defective is, firstly, to remove any co-existing disease which may, by its sympathetic reaction, occasion and keep up disturbance of the digestive system; secondly, to give the suffering digestion as little to do as is consistent with the nutrition of the economy, until disease is removed, and functional derangement subdued.

It is absolutely necessary that any general or local disease which reacts on digestion and nutrition should be subdued; otherwise the most scrupulous dietetic management and the most enlightened medicinal treatment fail to restore the digestive functions to a state of health. The morbid reaction of the general

or local malady being constantly exercised, undoes the good that treatment effects, and the defective state of the nutritive functions is indefinitely prolonged.

In the practice of medicine this important fact is constantly exemplified, but in no class of diseases is it more frequently and strikingly illustrated than in uterine affections. The sympathetic connexion between the uterus and the stomach is physiologically very great, as proved by the sickness which accompanies pregnancy. In uterine disease this sympathetic connexion is generally called into play, and, consequently, depraved digestion and nutrition is of constant occurrence. As long as the uterine disease is unnoticed or uncured, every possible means of treatment may be employed in vain to restore the digestive powers. Change of air, diet, medicine, all fail. But as soon as the uterine malady is treated and subdued, the very means which failed before prove readily successful.

The second indication is to give the digestive system, and especially the stomach, as little to do as may be consistent with the nutrition of the economy, until its powers are restored, the very reverse of what is constantly done. If weakness and emaciation are observed, the general tendency, as I have stated,

is to meet these conditions of the system by animal food, given frequently and at short intervals, and by alcoholic stimulants, in order to "support the strength and to remedy the weakness." The sinking, craving sensations of the patient render this plan of diet, in most cases, rather grateful than otherwise, as it temporarily remedies these painful sensations, and gives also, for the time, artificial strength. It is, therefore, readily adopted.

The slightest reflection must, however, show that this system of dietary is not calculated to restore the weakened, exhausted powers of the digestion. During the entire period of stomachal digestion the stomach is very actively engaged. Its glandular system is secreting gastric juice—a process attended, as we have seen, with the successive formation and destruction of gland cells; and its muscular structure is vigorously contracting so long as it contains food.

We must also bear in mind, that the more dense the structure of the food, the longer the stomach takes to dissolve it, and to prepare it for the subsequent digestive stages. Thus animal substances take a longer time than cooked vegetables; and the more compact the animal fibre, the longer the time employed in its dissolution. Cooked vegetables,

as we have seen, are dissolved by the gastric juice, and pass out of the stomach in from one to two hours; milk, eggs, and fish, in about two hours; fowl, and game, and mutton, in from two to three; beef and pork, in from three to four; salt meat, in four or more. In persons whose digestion is naturally slow, and in many in whom it is weakened by disease, the time employed is often much greater.

Such being the case, it is clear that the oftener food is taken into the stomach the more work that organ has to perform, and that the duration of its labours is considerably increased when meat is the principal article of diet.

The prevailing idea that there is immeasurably more nourishment in meat than in any other kind of animal food, is an error. Meat owes its waste-repairing or nourishing properties to the albumen, or nitrogen compound, which it contains. But albumen is also the principal element in all other kinds of animal food—milk and eggs, fish and fowl. The following table of Schlossberger and Kemp, quoted by Dr. Carpenter, in his "Principles of Human Physiology," conveys a good idea of the relative waste-repairing powers of different kinds of food, vegetable and animal. Taking human milk as the standard of comparison, the amount of nitrogen it contains is

represented as 100, whilst that contained by the other substances is represented by the figures appended to them.

Vegetable food.

Rice	81	Wheat	144
Potatoes	84	Carrots	150
Turnips	106	Brown bread	166
Rye	106	Peas	239
Maize	125	Haricot beans	283
Barley	125	Agaricus deliciosus	289
Oats	138	Beans	320
White bread	142		

Animal food.

Human milk	100	Herring, raw	910
Cow's milk	237	,, boiled	816
Oyster	305	Haddock, raw	920
Yolk of eggs	305	,, boiled	816
Cheese	447	Flounder, raw	898
Eel, raw	434	,, boiled	954
Mussel, raw	528	Pigeon, raw	756
Ox liver, raw	570	,, boiled	827
Pork, ham, raw	539	Lamb, raw	833
,, ,, boiled	807	Mutton, raw	773
Salmon, raw	776	,, boiled	852
,, boiled	610	Veal, raw	873
Portable soup	764	,, boiled	911
White of egg	845	Beef, raw	880
Crab, boiled	859	,, boiled	942
Skate, raw	859	Ox lung	931
,, boiled	956		

An attentive study of the figures contained in this table will show that the quantity of albuminous matter contained in fish and fowl is equal, in some instances superior, to that contained in meat.

Thus in boiled skate, flounder, and pigeon, the numbers are respectively 956, 954, and 827; whereas, in boiled beef and mutton the numbers are 942 and 852. Thus is demonstrated the important but little-known fact, that fish and fowl are just as nourishing, if they suit the state of the digestive organs, as beef or mutton, or any other kind of animal food. They contain, in reality, the nitrogenous elements required for the repair of organic waste in the greatest possible abundance, although erroneously supposed by the popular voice to be mere helps to nutrition, and not to be alone depended on.

In milk the nitrogen compounds—the albumen and the cheese, or casein—as also the carbon compound—the fat or butter—are held in solution by a considerable quantity of water. In eggs the white, or the albumen, and the yolk, or the fat, are also fluid, although in a more condensed state than in milk. In fish and in fowl the albumen is still more condensed, and is consequently solid. Whilst in meat, or the flesh of animals, the condensation is still greater; the albumen which composes the greater part of the muscular tissue being deposited, as it were, in a network of non-nutritious fibrous tissue.

Dr. Marcet has shown, in his interesting researches

into the nature of human alvine evacuations, that the residue of the digestion of meat is principally this innutritious fibrous network. As he states, the digestion of meat may be artificially imitated. If we take a small quantity of meat—beef, for instance, and after chopping it very fine, wash it in water, kneading and working it for a considerable time, it becomes blanched, whilst the water assumes a red hue. On raising this water to boiling temperature by means of a spirit or gas lamp, we find that a copious formation of coagulated albumen takes place, whilst the blanched residue, under the microscope, merely reveals, like the fæces, innutritious fibrous tissue. By chopping, kneading, macerating, we do what the stomach does by means of its gastric juice and its muscular contractions; we dissolve out the albumen.

From the consideration of the above facts, we may conclude that the time the stomach employs in dissolving and transforming into chyme animal substances introduced into its cavity is, in a great measure, regulated by the density of their structure. Thus it is that milk is sooner digested than lightly cooked eggs; eggs than fish or fowl; fish or fowl than meat; mutton than beef; and plain beef than salt beef. Acting on the first, the gastric juice easily dissolves elements that are but loosely aggregated. With

the latter, the process of solution is necessarily more lengthened, and the muscular contractions of the stomach are longer continued; for the food has to be turned over and over, and presented again and again to the secreting walls of the stomach, before it can be dissolved and reduced to a semi-fluid chymous state.

The nitrogenous or waste-repairing element being thus the same in these different kinds of animal food, and the relative proportion in which it is present being also pretty nearly the same, it is clear that they must all be nearly equally "nourishing;" and such is the case—only, they are not equally nourishing to all people.

The healthy, robust adult requires food that will give his digestive organs work to do. The muscles of his stomach require work, as much as the calves of his legs or the muscles of his back. The nitrogen or albumen he wants to repair the waste of his tissues should not be presented to him ready prepared, ready dissolved, as it is in milk and eggs; and it is better that he should extract it himself from meat,—a process which will give his digestive system the exercise it absolutely requires.

The case is, however, very different with the very young, with the sickly and with the dyspeptic invalid.

Nature has provided for the young of the mammalia, in milk, food containing all the elements of nutrition in a semi-prepared state, which only requires a very short time for its thorough transformation into chyle. The same may be said of all oviparous animals; for they live on the contents of the egg in the early stage of their existence. Nature has evidently wished to spare the delicate organs of the young, in the earliest period of life, the labour which they are destined later to undergo in the elaboration of their food.

In sickness and in deranged health the digestive organs lose their tone and powers, and should be treated as nature treats the young; that is, the kind of nitrogenous food should be given which entails the least work on the part of the stomach. It is weakened, its muscular and secreting powers are diminished, and it no longer requires for its health many hours of rude exercise daily. The rule should be, therefore, to give it, on the contrary, as much rest as is consistent with the duty it has to perform—that of furnishing nutritive materials to the economy. This can only be done by supplying it with the kind of nitrogenous food which is the easiest dissolved, and which takes the least time to transform into chyme. Such food, we have seen, is to be found in the fluid animal substances, milk, eggs, broths; and in those in

which the muscular fibre is loosely aggregated, fish, fowl, game, &c. The convalescent and dyspeptic, generally speaking, digest this kind of food easier, and with less suffering, than meat; so much so, that it constitutes the diet of the sick chamber.

Among the different kinds of meat, also, there are great differences: lamb and mutton are easier digested, because less compact, less dense, than beef; and meat that has been kept until it is tender, that is, until its compactness and density have been chemically modified, is more easily digested than meat freshly killed.

As we have already stated, most cooked vegetables, as also farinacea, bread, potatoes, rice, &c., are soon digested, and transformed into chyle; but as the quantity of nitrogen which they contain is small, they are only resorted to as adjuvants in the dietary of the dyspeptic or invalid. To feed an invalid entirely on vegetable food, so large a quantity must be taken, that the bulk would, in most instances, overload and oppress the weakened powers of digestion. Moreover, much more carbon would be ingested than is required for organic combustion, especially if the patient is protected from atmospheric influence; and if the adipose tendency existed at all in the constitution, it might lead to the

over-abundant deposit of fat. This result of an over-abundant supply of earbonaeeous food, purely nitrogenous food being at the same time withheld, is mueh less frequently observed in man than in animals: the latter are easily rendered adipose by over-feeding on earbonaeeous food, whilst in man, to develop the adipose temdency, a mixed dictary seems, generally speaking, to be neeessary. It would appear that, for fat to be formed from the carbon compounds ingested, it is absolutely neeessary that the organie nutritive powers of the eeonomy should be sustained by a moderate supply of nitrogenous food.

Uneooked vegetable substanees, sueh as carrots, turnips, cucumbers, or unripe fruit, the texture of which is close and dense, are much more diffieult of digestion than the same vegetables or fruits, softened by eooking or by ripeness. In reason of their density, the gastrie juiee has a diffieulty in dissolving them; thence partly their indigestibility.

Indeed, density of structure is evidently one of the principal eonditions that regulate the digestibility of both animal and vegetable food. The dense kind of meat, sueh as pork and beef, and hard vegetables, and fruits unsoftened by cooking, may be familiarly compared to eotton or hay eompressed by steam presses

for the facility of transport, until half-a-dozen bales or trusses are made to take the space of one. In such a comparison, the less dense kinds of food would represent intermediate degrees: the cotton or hay packed so as to take one-sixth part of the ordinary space would, of course, resist any dissolving power twice as long as that which had been compressed to only half the extent.

An important element in regulating the dietary of the healthy, as well as that of the invalid, is change: it is all but absolutely necessary that the diet should be more or less varied, for the digestive processes to be easily and healthily performed. The only two substances which probably contain all the elements necessary for animal nutrition are milk and eggs; and they alone are merely fitted for the early stages of viviparous and oviparous life. At a later period of organic development, when taken *alone* they appear to fatigue the digestive powers, to which they are evidently no longer suited, as the sole nutritive element. Many experiments and accidental facts have proved the necessity of a varied diet; and the very decided craving of the appetite for variety in food points to the existence of an innate instinct in this direction. As we have seen, when food is properly digested, and the chyle, resulting from the

processes of digestion, is assimilated, as is the case in normal nutrition, the urine remains clear, and free from all deposits both when excreted and on cooling. When, on the contrary, the digestive process is defective, and the chyle imperfect, deposits take place, formed of urate of ammonia and of other morbid salts, which render the urine turbid on cooling. In the dyspeptic patient many causes, usually but little studied and appreciated, will disturb digestion, and be followed by this result.

The stomach and digestive organs generally may have the power to dissolve and chylify the lighter or less dense kinds of food, and those only. In such cases cooked vegetables, in moderate quantities, and the lighter animal substances, such as milk, eggs, fish, and fowl, may be thoroughly digested, as evidenced by the immunity from subsequent pain or suffering, and by the absence in the urine, passed a few hours afterwards, of uric acid or of the turbid urate of ammonia deposit. But if the more dense forms of food—mutton, or beef, or pork, &c.—be taken, the stomach often seems to refuse to perform the increased work demanded of it; flatulence, oppression, acid eructations, &c., are experienced; and the urine on examination, four or five hours after it is passed, is found to be loaded with the morbid salts; and, on

cooling, becomes turbid, owing to the more or less abundant deposit of urate of ammonia.

It is worthy of remark, that pain and oppression, during the digestion of food, are not always the evidence of imperfect digestion. The stomachal elaboration of aliment may be laborious and painful, and yet complete; as evidenced by the absence of all deposit in the urine, which remains quite clear on cooling; and by the absence of the headache, want of sleep, loaded tongue, and of the other constitutional symptoms which nearly always follow disordered digestion. On the other hand, the elaboration of food may be unattended with any pain or discomfort, and yet be most defective; as evidenced by the copious deposit of urate of ammonia, and other morbid salts, from the urine; and by the loss of sleep, by the extreme constitutional distress which the patient subsequently experiences. This is often the case, both with the dyspeptic and with the healthy man, when more wine than usual has been taken with the meal. Although at the time all is *couleur de rose*, digestion is disturbed by the wine ingested in overabundance; the chyle is imperfectly formed, and is eventually, in great part, thrown out by the kidneys and liver, after poisoning the entire system as it passes through.

Again, if the digestive system is one that requires rest after the elaboration of food, and that rest is not given, it flags, does its work imperfectly, turbid urate of ammonia loaded urine is voided, and the entire economy is disturbed. As I have elsewhere stated, many persons in perfect health present this peculiarity of the digestive system,—they can only digest food thoroughly at long intervals; so that two meals, or three at the utmost, are all they require in the twenty-four hours. Unless they find out this peculiarity of their constitution, and conform to it, they inevitably become confirmed dyspeptics. The urate of ammonia test, the most delicate of all in my experience, is easily applied in such cases. Let those who suspect that such is their constitution merely make a light breakfast and an ordinary dinner for a few weeks, examining the urine three hours after breakfast, and four or five after dinner. They can then modify the experiment by making three or four meals a day—breakfast, lunch, dinner, and tea; or, breakfast, dinner, tea, and supper. If they find that in the first case the urine remains free from turbidity and morbid deposits, whereas in the second it shows both, they may conclude that the first system suits them, and that the second does not: the converse is equally true.

This simple investigation of the physical condition of the urine on cooling, will also throw light on the individual caprices or idiosyncracies of the digestive powers. These idiosyncracies are infinite, and quite unreducible to any rule. Thus one person cannot properly digest the first meal, breakfast, unless it be taken immediately on rising, whilst another must be up and about for one or more hours, before the stomach is sufficiently roused to perfectly carry out the digestion of food. Again, one person can only digest the principal meal of the day if taken at mid-day—at one or two o'clock; if a later hour is chosen, faintness and loss of appetite ensue, and the meal is imperfectly elaborated: whilst another has a fit of indigestion, if the dinner is taken early, but can digest the identical meal with ease, if the hour is four, five, six, seven, or even later. In recognising and giving their due weight to these individual peculiarities, we must not forget that they are often the result of habits, early acquired, as elsewhere explained.

The above facts, which are deduced from the careful investigation, during many years, of the urine of large numbers of dyspeptic patients, show clearly that it is impossible to lay down general dietetic rules: each case must be studied by itself, and the advice given must be modified according to the results of the

study of each individual. The existence of urate of ammonia in the urine, a few hours after the ingestion of food, presents, however, in most cases of disordered digestion, an easy means of arriving at the required knowledge. The circumstance of this salt rendering the urine turbid when it cools, makes it quite possible for the patient himself to carry on the investigation, once the physician has ascertained that the turbidity is owing to the presence of a lithatic deposit, and not to pus, &c. Thus, an Ariadne thread is placed in the hands of the dispeptic patient, which may enable him, with some slight assistance from his medical attendant, in the way of explanation and direction, to guide his own path through the dietetic labyrinth. He may thus learn, to a certain extent, what kind of food suits him individually, what amount he can take, and at what intervals and hours it is required in his own particular case: should, however, uric acid, oxalate of lime, or the triple phosphates, be present without the urate of ammonia, this information could, of course, only be obtained by microscopic examination.

The same mode of study may be applied to beverages, and their influence on digestion. If alcoholic stimulants are beneficial, they will not disturb digestion, and the urine will remain as clear, as free

from morbid deposits, as if they had not been taken; but if, on the contrary,—as sometimes occurs, even with the healthy, and very frequently with the weak and dyspeptic,—beer, wine, or spirits, even when taken in moderation, render the urine turbid and lithatic, evidently disturbing digestion, they assuredly can do no good: indeed, far from doing good, they are a snare and a delusion, owing to the temporary feelings of strength and comfort which they give rise to, at the very time they are, in reality, poisoning the economy.

Many persons in perfect health, as we have already stated, may observe on themselves how alcoholic stimulants thus tend to disturb digestion, by noticing the state of their urine the morning after a dinner or festival, at which they have taken more wine than usual. They will often find it densely turbid, from urate of ammonia deposit; the evident result of the disturbance of their digestion, occasioned by the unusual amount of stimulants ingested. What the extra quantity taken does to them in health, a very small amount may do in one whose digestive system is already weakened, and who is already suffering from dyspepsia or from some other kind of illness.

Tea and coffee, and all nerve stimulants of the same class, may likewise disturb digestion, and their

use may be followed by lithatic urine, especially if they are taken in a very concentrated form. They are, however, undoubtedly less liable to produce this result than beer or wine, probably because their action is confined to the nervous system, and because they do not interfere with the organic combustion of the chyle and of the products of molecular disintegration.

Coffee and tea afford but little nourishment to the economy, but appear to have a peculiar power of arresting the molecular waste, and of thus diminishing the amount of nutritive materials required. Supposing the daily waste of the economy to be represented by thirty, under the influence of a fair supply of coffee or tea, the waste might be reduced to twenty-five: if so, only five-sixths of the food usually required would be necessary; there would be a saving of one pound out of six. Thus is explained the desire of the poor for strong tea. It does not nourish them, so much as it prevents their wanting so much food; moreover, it is a powerful stimulant of the nervous system, and supplies the universal craving for stimulants, to which allusion has already been made.

All fluids which contain nutritive substances in solution entail digestive labour on the stomach. Even water cannot be absorbed without rousing to a

slight extent its functional activity. This fact is illustrated by the oppression, discomfort, and absolute pain which follow the ingestion of any fluid in many dyspeptic patients. The process of digestion is a painful one with them, whether it is solids or fluids that they have to digest and assimilate.

The deduction we may draw is, firstly, that pain after the ingestion of fluids should not prevent their being taken in sufficient quantity for the wants of the system,—a mistake many dyspeptics make. Secondly, fluids should not be taken between meals, and more especially when the digestive process is accomplished, the stomach's rest being thereby disturbed.

CHAPTER VI.

CONFIRMED DYSPEPSIA.

We have spoken, hitherto, of the cases in which the urine is not constantly loaded with morbid salts after food, and in which, by the exercise of care and discrimination, by attention to the quality, quantity, and periodicity of food, its digestion could be secured without the formation of imperfect chyle, and the elimination of urate of ammonia through the kidneys, and of imperfectly elaborated bile through the liver, with the concomitant tendency to bilious attacks. In the confirmed dyspeptic, however, and in the patient suffering from stomach disease, or in whom the digestive and nutritive functions generally are weakened by the sympathetic re-action of other diseases, the urine may be *always* lithatic after food, whatever its nature; the urine may even be lithatic when there is no food in the economy.

When this occurs, we have no longer the guide

afforded by the occasional presence of lithates in the urine, the result of dietetic errors with regard to the quality or quantity of food, or the hours and frequency of meals. We have no longer merely to guard against errors which the study of the individual case reveals, and enables us to remedy; for the urine is constantly loaded with morbid salts. Both reason and experience, however, show that the same rules apply to these cases, that apply to minor forms of nutritious derangement; only these rules must be applied with much greater rigour and perseverance.

In such cases, more especially when the stomach is diseased or weakened, its secretions depressed or deficient, and its muscular powers diminished, it is most irrational to keep it at work the greater part of the twenty-four hours, under the absurd assumption that it ought not to be left empty. It would be as rational to keep a man with a sprained knee or ankle constantly walking, in order to strengthen the joint. In fact, the great drawback to the recovery of a patient whose stomach and digestive system is permanently out of order is, that the organs *must* be kept at work, or the economy would waste and perish. The object of the physician, in such cases, ought to be to regulate the dietary so as to attain the ends of

nutrition with as little vital and muscular effort to the stomach as possible.

In pursuance of this view, food should only be taken two, three, or four times in the twenty-four hours, according to the age, sex, and constitution. Children require food oftener than women; women oftener than men; the young and old generally oftener than the middle-aged. The food itself should be of a kind calculated to afford the principal elements of nutrition—nitrogen and carbon, with the least possible amount of digestive labour. Thus meals in which milk, eggs, butter, gravy soups, fish, fowl, game, cooked vegetables, and well-fermented bread form the principal ingredients, only give the stomach two hours' or from two to three hours' work. Yet they contain nitrogenous elements in abundance, although not perhaps in as great abundance as if the dietary were mutton and beef, veal or ham. Thus, a breakfast of weak tea, coffee, or cocoa, made with plenty of milk, if the stomach will bear it, with bread, or toast and butter,—a mid-day dinner of fish, or fowl, or game, or mutton in moderate quantity, with a little gravy soup, if it agrees, and vegetables, or a bread-and-butter or rice pudding, in order to make up in quantity, when the appetite is good,—and a tea supper at six or seven, consisting of weak tea,

with or without an egg, and a little bread and butter, will afford the economy all the nutritive materials it can possibly require under ordinary circumstances.

Such a dietary, at the same time, only represents about seven hours' work for the stomach. The digestive organs will thus have seventeen hours' rest to recover themselves. To many, breakfast at nine, and dinner at four, five, or six, with or without a cup of weak tea in the evening, prove sufficient. If so, it is for them the best system, as the economy is then nourished with five hours' stomach work, and nineteen hours are left for rest. It is worthy of remark, that in the early stages of life, when the craving for food is great, the night sleep is very prolonged, generally lasting from ten to twelve hours, so that a long rest is afforded to the highly vitalized digestive system.

Whether dinner is taken early, and tea late, or a light lunch is taken at mid-day, and the dinner is late, some dyspeptic persons really cannot rest, unless food is ingested the last thing; in such cases, a basin of gruel, or sago, or arrow-root, or a little bread and milk is all that should be allowed, until the habit can be got rid of; light food of this description being soon digested. A heavy night meal, or even a light one of solid food, necessarily entails

hours of labour on the stomach, and that when it is weary with the day's work. Thence its frequent rebellion, and the sequel, restless sleep, painful dreams, and the nightmare, or positive indigestion. The late eight o'clock dinners of fashionable life are often followed by these results; for they are in reality suppers. Were those who partake of them merely to make a light mid-day meal, they would not be quite so objectionable; but as it is difficult to wait until so late an hour for the principal meal of the day, very many persons have a hot lunch, and in that case they really dine twice, the late dinner being in reality a heavy supper. To the dyspeptic, such a regimen is perfectly poisonous, and the strong and robust often succumb to its injurious effects, and become confirmed dyspeptics.

When the attempt is made, in accordance with the above views, to afford the stomach as much rest as is consistent with the nutrition of the economy, by giving easily digested food, and at intervals as distant as possible, we must take care that enough of the elements of nutrition are ingested to satisfy the requirements of the economy. To secure this very necessary point, it is well for the patient to be weighed once a fortnight or once a month, care being taken to wear the same dress. Thus we ascertain to an

ounce whether he or she is losing or gaining ground, or remaining *in statu quo*, and we can regulate the amount of food accordingly. As long as there is no loss in weight, we have unmistakeable evidence that the food supply is equal to the nutritive demands of the economy, however moderate the former may be. If, on the contrary, there is a loss of weight, it is equally evident that the supply of food is not equal to the nutritive demands, or that a due amount of nourishment is not extracted from it; and it may become advisable to increase the amount, unless, however, the loss were at the expense of an accumulation of fat, which we wish to diminish or to get rid of.

As we have seen, stoutness from the deposit of fat is neither an evidence nor a condition of health, and its diminution is a positive advantage when its presence is carried to an excess. The deposit of fat in excess can only be remedied with safety by reducing the supply of carbonaceous food below the requirements of the economy, at the same time that the functions of organic life are rendered more active. Thus sleep should be reduced to the amount strictly necessary—seven or, at the utmost, eight hours; the muscular system should be brought into active play by exercise, which increases organic combustion; and a slightly in-

sufficient amount of carbonaceous food should be given. To meet the increased requirements of the organization, which the food consumed does not entirely supply, the fat deposited throughout the body is thus gradually absorbed. We must, however, never attempt to progress too energetically in this direction, lest we should weaken the organization by thus forcing it to feed too rapidly on itself, owing to insufficient supply of the materials of nutrition: a diminution of weight amounting to a pound or two a month is quite as much as it is prudent to obtain.

The same result may, in some cases, be attained by exercise and exposure to the atmosphere, without diminishing the dietary. It is, however, only to be secured by an amount of exercise which is, generally speaking, quite incompatible with the diminished muscular strength of corpulent persons. Walking must be carried to six, eight, or ten miles daily; riding, to fifteen or twenty. Moreover, such an amount of exercise requires the daily sacrifice of more time than those who are engaged in the active duties and pursuits of life can usually devote to health claims.

My experience in the management of persons presenting corpulency and general fat-deposits as a complication of disease has led me to the conviction

that this condition of the system may be remedied, and the tendency may be controlled, in nearly every instance, with perfect safety to the individual, by the above means. There is, however, as already stated, scarcely one person in twenty who will submit to the constant self-sacrifice and discipline which is implied by conforming to the principles laid down. These principles may be recapitulated in a few words: daily exercise carried to the extent stated above, but in accordance with sex and strength, in fair weather or foul; abstinence, total or all but total, from alcoholic stimulants; and the reduction of food, especially of carbonaceous food, to such an extent as to be attended with the slow but constant diminution of the weight, as tested by the scales,—all other tests being delusive.

The difference in the nutritive powers of different individuals, or of their capacity of extracting nourishment from the same food, is so very great that it is vain to attempt to lay down any limit as regards the amount of food that will merely supply wear and tear and organic combustion, and that which will, in addition, allow of the formation and deposit of fat. One person will thrive and grow fat on what would starve another, and soon produce emaciation. It is, therefore, only by weighing the patient at short

intervals, and comparing the weight with the amount of food ingested, that we can ascertain the quantity required by the person under observation.

From what precedes, it is evident that it is by no means requisite for an individual, dyspeptic or not, to be a large eater, to grow fat and corpulent; although I firmly believe that all those who have become so either are or have been endowed with a good appetite, which they have gratified for a longer or shorter period. It must be remembered that a very small amount of carbonaceous food, in addition to what the economy really requires, will create half an ounce of fat a day. A glass of beer, one slice of bread and butter, one egg, a little light pudding, more than is wanted for normal nutrition, will amply suffice. Half an ounce a day is a pound a month, and a pound a month is nearly a stone a year. Now, one or two stones added to ten or eleven make all the difference between spareness and corpulence. That a very small amount of surplus carbonaceous food should be followed by fatness, when the constitutional tendency exists, or when the digestive and nutritive powers are weakened, is not surprising, when we consider that the greater part of the food we daily consume is transformed into chyle, and ought to be used in the nutritive processes. The alvine evacua-

tions, as we have seen, do not amount to more than four or five ounces in a healthy man, physiologically but not overabundantly fed. If, therefore, more chyle is formed than is required for the purposes of assimilation and organic combustion, is it surprising that the carbonaceous element, which has not, perhaps, so ready a vent in the liver as the nitrogenous has in the kidney, should be deposited throughout the economy in the shape of fat?

When the diet is diminished, with the view of reducing fat deposits, the diminution must necessarily bear principally on the carbonaceous element, and that is much better done by striking off one meal entirely than by avoiding this or that article of food,—a plan which makes diet rules irksome and painful to follow. The patient must not also fall into the error of increasing the supply of nitrogenous food, because he takes less of the carbonaceous; for all animal food contains carbon, as nearly all vegetable food contains nitrogen. Moreover, the stomach is thereby loaded with nitrogenous nutritive materials, which the economy does not want, which overload it, and produce disease.

In regulating the dietary of those who are suffering from defective digestion and defective nutrition in a confirmed and chronic stage, the question of the ad-

vantage or disadvantage of alcoholic beverages occupies a prominent position, and requires careful elucidation. The debility and langour which usually exist in such cases as a painful reality, and which are the immediate result of the defective elaboration of nutritive elements, are, *for the time*, remedied by alcoholic stimulants. Wine, malt liquors, brandy, etc., stimulate the nervous system of the weak or dyspeptic patient, and give for a short period artificial strength. He who could neither think nor act, whose brain was clouded, and whose muscles were powerless, recovers under their influence, temporarily, the deficient mental and bodily energy. No materials, however, for the repair of wasted tissue have been afforded,—or, at least, none which the economy can or will use,—and once the influence of the nervous stimulation has been exhausted, a collapse generally follows, and the debility and langour are greater than ever. This is a law of nature; all artificial stimulation is followed by a proportionate exhaustion of the function stimulated. Under the influence of the excitation of the brain which accompanies the delirium of fever, the wasted patient summons to his aid muscular power sufficient to try the strength of half-a-dozen persons. But when the fever and delirium have subsided, collapse follows; he can then scarcely raise his hand from the

bed, and a child could hold him. Such strength, however, as that which alcoholic beverages give to the weakened dyspectic is a mere delusion, which does harm in many ways. On the one hand, it exhausts the remaining vital power of the organization, without any commensurate advantage; on the other, it deceives both the patient and his medical adviser,—the patient, by endowing him for a time with powers which he has not in reality, thus masking his real condition, the physician, by persuading him that he has really given strength, when he has only stimulated the nervous system. In a word, if the patient is exhausted, weak, debilitated, unable to go through the duties of life, it is much better that this, the real state of the economy, should be recognised and accepted, and its causes struggled with, conscientiously and scientifically, than that his condition should be obscured by any kind of alcoholic stimulant.

Perhaps the greatest real advantage which a person debilitated by defective digestion and nutrition derives from alcoholic beverages is, that they assist in the generation of heat. The economy will burn alcohol when it can with difficulty burn imperfectly formed chyle, or when chyle is not generated in sufficient quantity to supply the demand for organic fuel. It is partly because this is the case that the ingestion of

alcoholic fluids is attended, as we have stated, with the sensation of an agreeable glow, which pervades the entire economy, and is followed by great apparent comfort and relief.

Were this relief unattended with any serious drawback, alcoholic beverages would really be a sheet-anchor in the treatment of defective nutrition; but such, unfortunately, is not the case. There is a drawback of a very serious nature, which has been already explained, viz., the arrest of destructive metamorphosis, and the interference with the organic combustion of the products of molecular disintegration, and with the formation of protein compounds in the blood. The blood, as we have already seen, thus becomes loaded with effete carbonaceous and nitrogenous elements, which the natural emunctories have great difficulty in removing. Moreover, observation has proved to me and to others that the direct influence of the alcoholic element on the organs of digestion in the dyspeptic patient is pernicious, probably through the over-stimulation and irritation which it produces on organs already disordered and suffering. This rule, in my experience, scarcely suffers any exception. The exhibition of alcoholic beverages appears to me all but constantly to aggravate the deranged state of the digestive organs, to increase the

formation of lithatic and other morbid salts in the urine, and to perpetuate their presence. So convinced am I of this fact, that I have no hesitation in saying that all those whose urine is turbid and lithatic after the digestion of food are better without alcoholic stimulants of any description, until their digestion has been restored to a normal state. A slight concession may be made to extreme debility, to previous habits, to preconceived ideas, or to the prejudices of those who surround the patient; but with a few exceptions, belonging to the two first categories, the concession is merely damaging to the patient, and makes his recovery only the more tedious.

When, at last, the digestive functions are rallying,—when more exercise, more exertion, more exposure to atmospheric vicissitudes, becomes possible and desirable, and the urine clears after food,—the indications change. The nutritive and heat-generating requirements necessarily increase, and a limited amount of alcoholic stimulant, in the shape of wine or beer, may be given, in order to afford the necessary supply of carbon, without overloading the stomach with food. The less alcoholic wines, taken with water, are the most suitable. But this change should be made very cautiously; the state of the urine should be watched, and on the slightest re-appearance of the

turbidity occasioned by the morbid salts, the patient should return to water as the beverage.

We may therefore say that, as a rule, the confirmed dyspeptic should be a water-drinker, until he has recovered his strength and health. As we stated in the first part of this work, it is the robust and the strong, who have to bear the active duties, the fatigue and exposure of ordinary life, who can, not only with impunity but with positive advantage, consume alcoholic beverages. The weak and the debilitated, when the cause of their debility is disordered digestive power, are better without them, if they wish to get well, and not merely to pass from one day to another, and from one hour of the day to another, by the aid of an artificial stimulus.

Such a stimulus, although it gives apparent strength, in reality produces positive injury, and renders the epoch of recovery more and more distant. What should we say of a surgeon who handed crutches to a patient complaining of lameness, as a remedy for his ailment? Should we not feel that his duty to his patient would be better performed were he to examine into his real state, to see whence his lameness proceeded, and to treat the cause before he advised the crutches? And yet, such is the line of conduct of the practitioner who advises stimulants to

a dyspeptic patient because he is weak. The sufferer had better feel weak than gain temporary strength by means which only lead to a greater collapse, and to an exaggeration of the cause of his weakness. He had better be cold and chilly, and seek a remedy in artificial warmth and clothing, than gain it temporarily by agencies which increase the digestive disorder—the real cause of his chilliness.

The remarks made respecting the non-alcoholic stimulants, coffee, tea, &c., when speaking of the occasional dyspeptic, are still more applicable in the case of the more confirmed sufferer. They are not well borne by those who are labouring under chronic derangement of the digestive organs; they appear to stimulate too powerfully the local and general nervous system, producing spasms and heartburn, and their ingestion is generally followed by an increase in the morbid urinary deposits.

At the same time, even when indiscreetly taken, they are infinitely less pernicious than alcoholic beverages. They neither stimulate nor excite the nervous system to the same extent, nor do they interfere with the organic combustion of the elements furnished by molecular disintegration. Very weak tea, however, such as would be given to a child three or four years old, and equally weak coffee, or milk

flavoured with coffee, as taken on the Continent—weak *café au lait*—has not appeared to me, generally speaking, to exercise any perceptibly pernicious influence. On the other hand, the slight stimulus afforded by tea or coffee, even thus diluted, is often very grateful to the dyspeptic patient, and its administration solves a difficulty in dietetics, by affording an agreeable and yet innocent beverage for the morning and evening meal.

If we analyze the fundamental laws of hygiene, we shall find that they are all subservient to perfect nutrition,—indeed, inseparably connected with it. The oxygen we extract from the atmosphere during respiration is as much food as the flesh and farinacea which we introduce into the stomach, and the purposes it has to fulfil are equally important. If possible, they are more so; for the introduction of oxygen into the animal economy begins with the first "breath of life," and continues unceasingly until death closes the scene. Moreover, the oxygen introduced into the system, as we have seen, not only combines with the elements of food to construct, to build up the tissues of of the economy; it also combines with them in other proportions during their disintegration and elimination;—when, having served their time, they die and are thrown out. Thence the absolute necessity of an

abundant supply of pure atmospheric air. For want of it nutrition *must* flag; for, on the one hand, the construction of new tissues is defective, and on the other, the elimination of those that are worn out is imperfect.

The most strict attention to the dietetic rules laid down in the preceding pages, and the complete removal of any co-existing disease, often fail to restore digestive and nutritive power, if the laws of hygiene are neglected. Plenty of pure atmospheric air to breathe, regular exercise of the muscular system, a sufficiency of sleep at regular and proper times, and cleanliness of the skin, are essential requisites; their entire or partial neglect is a serious and often unsuspected obstacle to the recovery of nutritive health.

In country life the supply of what may be termed atmospheric food (oxygenous) is, generally speaking, much more abundant than in town life, owing to the habits of those who make it their residence. More time is spent in the open air, and the habitations are generally more spacious and airy. Even a farm-labourer has a cottage to himself. He is not, with his wife and children, huddled into a hermetically closed room, a few feet square, as is the case with the majority of town artizans. Consequently organic nutrition with him is

more perfect; he inspires more oxygenous food, and the processes of digestion and nutrition are more perfectly carried on. Like a lamp or a fire in a well-ventilated room, his economy burns brightly and vigorously.

It is a common idea that in the country, far from the influence of large towns, and especially in mountain regions, we find a more highly oxygenized atmosphere, and that this is the cause of its greater salubrity. This, however, is an error. The oxygen of the atmosphere is in a state of mixture with the nitrogen and carbon, in conformity with the law of the diffusion of gases, and in the open air is always found in the same proportion. Thus, whether examined in Shoreditch or on the top of Snowdon, twenty-one per cent. of oxygen by measure only will be found combined with seventy-nine of nitrogen; neither more nor less in either locality. The superior salubrity of the mountain air is derived, not from its containing more oxygen, but from its being free from the gases and emanations which towns and low marsh lands create and disseminate. The greater freedom also with which the atmosphere circulates, and plays round the frame in elevated spots, contributes no doubt to the beneficial effects which mountain air appears to produce.

Although the chemical composition of the atmosphere out of doors, as far as the presence of oxygen is concerned, is pretty nearly the same in town and in country, the habits and occupation of citizens expose them much more frequently and continuously to breathe an imperfectly oxygenized atmosphere. When the air of a room imperfectly ventilated is breathed by one or more human beings, it is rapidly deteriorated. On the one hand, oxygen is abstracted by respiration; on the other, carbonic acid is emitted; and thus the air is rendered doubly deleterious. Its vivifying, vitalizing element is diminished; and a deleterious, poisonous ingredient is generated. The influence of artificial light—candles, lamps, and gas—and of fires is the same. Oxygen is consumed; carbonic acid is emitted. Thus is explained the noxious influence exercised by crowded rooms; by the massing of work-people in badly ventilated localities; by that of the members of a family in one small room; and by want of ventilation under any circumstance in town or country, where animal life and combustion are deteriorating the atmosphere.

Indeed, even in the country, an atmosphere really pestilential, calculated to produce typhus fever, or any other disease of that category, may be produced by the want of ventilation. The same condition may be

produced in a palace, simply by closing the windows, doors, and grate of the room in which many hours are passed. In many airy, healthy houses, bed-rooms are rendered all but pestilential by the hermetic closure of every cranny by which air can enter. If one or two people sleep in a small carpeted room, with the door and window hermetically closed, and the chimney stopped up to prevent draughts, how can they expect to sleep soundly, and awake refreshed? They have very soon consumed all the air in the room; all ingress is closed to a fresh supply, and they then begin to undergo a course of poisoning from the air they have themselves contaminated. Thus the infringement of an important hygenic law may inflict the same penalty on the inhabitant of the spacious and luxurious palace and on the half-starved inmate of an Irish cabin.

I have many a time discovered that the morning headache and lassitude of a patient was owing to this cause, and have found it disappear simply by their leaving the bed-room door ajar, or opening the window half an inch or an inch, or even by merely throwing open the grate. It is worthy of remark, that the wide open chimneys of our ancestors, through which you could often see the sky, were much more hygienic than our more com-

fortable register stoves ; they were really ventilating shafts.

Town life has another disadvantage. It withdraws those who adopt it from the influenee of daylight and sunshine, and that in two ways. Firstly, town oeeupations are mostly earried on indoors and in the shade; seeondly, the oeeupations and pleasures of life are carried into the night, and sleep is eontinued, to a eonsiderable extent, into daylight.

It has been an axiom from time immemorial that, for health, sleep should be taken during the still hours of night, and not during the day. The example of the ruddy, healthy peasant, who retires to rest with his eattle, and is up with the lark, has been quoted a thousand times. It appears to me, however, that the undeniable faet of exposure to the light of day being an element of health, which vivifies and reddens the blood, was never satisfaetorily explained until the publieation of the experiments of Dr. Edward Smith, of the Brompton Consumption Hospital. Dr. Smith has proved that light is a powerful stimulus to respiration; that under the influenee of daylight one-third more atmospherie air enters the lungs than during darkness, or even under exposure to artifieial light. In other words, if in daylight, during a given time, six hundred eubie inehes of atmospherie air were

inspired, during the same time at night only four hundred would enter the lungs.

As the oxygenation and subsequent reddening of the blood depends on its contact with atmospheric air in the lungs during respiration, it is clear, if we accept the above statements, that the more the body is exposed to sunlight the more oxygen it will imbibe. As a necessary sequel, the more oxygen enters the economy, the more perfectly all the vital processes which require oxygen will be performed.

Thus is satisfactorily explained the fact which we daily witness—the pallidness of the inhabitants of cities, who live constantly in shaded rooms and streets, and who sit up late and get up late. Not only do they spend their lives in habitations shaded from the vivifying rays of the sun, but they turn night into day, carrying their avocations, studies, or pleasures into the night, when respiration is imperfectly performed. When asleep even, they remain in darkened shutter-closed rooms until the sun is high on the horizon; thus prolonging the period of imperfect respiration.

The climax of this anti-hygienic arrangement of life is seen in the female votaries of fashionable society, who, night after night, only retire to slumber in a darkened room when the sun has already cast his

vivifying rays on the face of nature. Can we be surprised that the lily should take the placc of the rose on their complexions, that languor of the vital functions should follow, and that tubercular deposits and other fell diseases should occupy half-vitalized economies?

Sleep, to be sound and refreshing, should be regular in its periodicity. We are the creatures of habit to a very great extent. All our functions have a tendency to settle down into pcriodicity, and it is vain to attempt to strive against what is a law of nature. The invalid, therefore, who is more especially bound to do all in his power to second the efforts of nature, should always retire to rest at the same hour. He should also rise at the same hour, taking every night the same amount of rest—from seven to nine hours, according to age, sex, constitution, and strength.

Ncxt in importance among hygienic laws is regular exercise, the value of which cannot be overrated. Man is not merely made up of rcspiratory and digestive or nutritive organs, he is also endowed with muscles—organs of locomotion and action, destined to carry him from one place to the other, and to execute his will in a thousand ways. The healthy state of the muscular systcm, which is inscparably mixed up with that of the organic, can only be kept up by muscular exercise. Exercise implics organic changc, waste, and

reconstruction, as we have seen; and organic change, we know, is indispensable for organic health. How rapid that change must be will become at once apparent if we consider the immediate results of exercise, —of walking, for instance. In a mile there are 5280 feet, and in walking a mile there are at least half that number of steps taken. In every step we take there is contraction, directly or indirectly, of some scores of muscles, indeed of a large proportion of the muscles of the economy. Thus, in a four-mile walk, these muscles must contract some 10,000 times. Now, as each contraction is attended with destruction of muscular fibre, which has to be repaired, some slight idea may be formed of the vast amount of organic waste and subsequent repair entailed upon the economy by an ordinary walk. If the exercise is regularly repeated every day, it must be evident that the organic vital activity of the muscular system must be wonderfully vitalized and accelerated, to the infinite advantage of the entire economy.

These physiological effects explain the prostration of an invalid, or, indeed, of any one unaccustomed to exercise, after a great muscular effort. They feel languid and exhausted, have pains in the muscles, and cannot sleep. They have used up, wasted part of their muscular structures, and there is not sufficient

organic activity in the economy to rapidly renew the destroyed fibre; so the feeling of fatigue and prostration lasts. This, however, is not a reason for renouncing exercise as an impossibility, as not agreeing with the constitution. A small amount only should be taken regularly at first, persevered in whether agreeable or not, and gradually increased, as the muscular power increases, which it is sure to do. I have found Payne's pedometer a most valuable aid. It marks, with great accuracy, the distance walked; so that the invalid can measure, to a hundred yards, the extent of his perambulations, although he vary them to any extent.

The use of the pedometer for a few days casts a singular and interesting light on the physiological results of habits. Active people, even in-doors, take a deal of exercise. They are ever on the move, running upstairs or down, fetching all they want, and waiting both on themselves and on others; and that even when surrounded with domestics. Such persons, on wearing the pedometer, find that they have walked many miles in the course of the day, without ever leaving the house. This is the history of female servants, who often never go out of doors from week's end to week's end, and yet usually retain good health.

Scdentary people, on the contrary, persons of indolent habits, who nevcr move from the chair or the sofa, if they can help it, and who ring the bell for all they want, reach the end of the day with scarcely a mile indicated on the tell-tale dial of the silent monitor. Not only, therefore, do they esehew exercise out-of-doors, but they do not even take it in-doors. Is it surprising that they should grow obese and unwieldy, and a prey to the diseases of a torpid, sluggish vitality?

In some form of dyspeptic suffering, in uterine disease for instance, there is concomitant disease which renders walking cxercise impossible, or nearly so. Such a condition is a serious and unfortunate complication. When it exists, the patient should go out daily, if possible, in an open carriage or in a bath-chair, and in summcr sit as much as possible in the opcn air and at sun-lit windows. He or she should, in a word, seize every opportunity to take "sun-and-air baths."

Material bcnefit is to be obtained in confirmed dyspepsia by strict attention to the hygiene of the skin, itself an important cmunetory organ, which, as we have seen, assists both the liver and the kidneys in purifying the blood of carbon and nitrogen. The entire body should be wcll washed with soap and

water once a week at the least, and then well rubbed with a course towel or with camel-hair gloves. When possible, and the state of the patient admits of the remedy, a tepid or cold sponging bath, or shower-bath, should also be used daily. The pores of the skin are thus kept open, and the cutaneous circulation is tonified and vitalized.

We have a marked illustration of the beneficial effects, in chronic dyspepsia, of combining strict attention to diet and hygiene with cold ablutions, in the success which occasionally follows this treatment in hydropathic establishments. In these institutions, the inmates are obliged to retire to rest at ten, and to rise at six; are debarred from all stimulants, and restricted to the lightest and simplest food. They are encouraged in every way to take regular exercise in a pure atmosphere, in the midst of interesting scenery. They are removed from the cares and anxieties of their usual life, and, lastly, are submitted to a course of ablutions and water-treatment, which, if not carried to excess, promotes the healthy action of the cutaneous functions. Is it surprising that many, in whose home-life every possible hygienic, dietetic, cutaneous, and medicinal error is accumulated, should rally and recover their digestive powers under so wholesome and salutary a discipline?

By adhering strictly to the dietetic rules laid down in the preceding pages,—which have for their object to afford nutritive materials to the economy with as little labour to the digestive organs as possible,—by treating, at the same time, any local or general disease which may coexist, and by attending to the laws of hygiene, we may expect to see the digestion gradually improve. The urine first ceases to contain uric acid, urate of ammonia, and other morbid salts, except after the digestion of food. We can then carry out the experimental essays, as to individual digestive peculiarities, which I have described at length. By so doing we attain a knowledge of the patient we are treating, which enables us to lay down the code of dietetic rules which are calculated, in his individual case, firstly to recover and then to retain digestive and nutritive health. It is of but little use to merely restore a dyspeptic patient to health, unless we teach him to "know himself," and to appreciate the peculiarities of his own organization, and unless we give him a guide which he may safely follow to avert the the ills from which he has recovered.

This guide exists, as we have seen, for most dyspeptics, in the simple ocular inspection of their urine a few hours after taking food. If it becomes turbid, the thermometer being under 50° or 60°,

they may be certain that they have not perfectly digested the previous meal, and that there is "something wrong,"—that there is a cloud on their horizon. Either they are getting out of health, and the digestive functions are becoming depraved, or the meal has been an error as to quantity, quality, or time. In the one case the alarm should be taken, and the health attended to; in the other, the error should be ascertained and avoided.

The defective state of nutrition which is indicated by the presence of lithates and other morbid salts in the urine is, no doubt, a fruitful and all-important cause of disease, both general and local. On the one hand, tissues formed of chyle so imperfectly elaborated that a considerable portion of it has to be eliminated from the blood as a poison, by the kidneys, liver, and skin, cannot be endowed with the same vitality and power of resisting morbific agencies that they would have enjoyed had the chyle been perfectly healthy; on the other hand, the blood itself is contaminated until the emunctories have done their work, and purified it. We have an illustration of these facts in the prostration of body and mind, in the headache, parched mouth, and debility that follow a debauch of food, as well as one of stimulating beverages. When this is the case, the stomach has failed, under the over

work thrown upon it, and imperfect digestion, with lithatic urine, has ensued. Many diseases, both constitutional and local, which are only studied by the medical practitioner under whose eye they fall, as morbid entities, are, I feel convinced, preceded and occasioned by years of defective nutrition. This condition has passed unnoticed and untreated, notwithstanding the presence of lithatic urine as the ordinary condition.

The kidneys and the liver, however, are more especially exposed to danger; they are, as we have seen, the principal emunctories through which defective chyle is eliminated from the blood, and consequently they are the organs the most likely to suffer.

Irritability, amounting sometimes to sub-acute inflammation of the kidneys, ureter, bladder, and urethra, is constantly met with as the result of the presence in the urine of morbid salts. Indeed, I am never without cases of this kind under my care. What proves that the lithatic and other morbid formations are the cause of the irritability of the urinary organs is, that the latter is generally incurable as long as the urine contains them, whereas it gradually subsides in most instances, even without treatment, as soon as the urine is cleared of their presence. The more serious and fatal forms of kidney disease no doubt often

originate in irritation thus induced. The kidneys may excrete these morbid products from the blood for years, with little or no evil result to their own structure, but at last disease sets in. In some instances, also, urinary calculi form, the chemical nature of which varies of course according to that of the salt contained in the urine. These are precipitated in the calices of the kidneys or in the bladder, the urine being unable to retain their elements in solution, owing to over-saturation or other causes.

Derangement in the functions of the liver, congestion, bilious headache, and diarrhœa, indeed, all the common forms of biliary derangement, I constantly find to be the mere result of defective nutrition, as evidenced by urinary deposits. The proof is, that they generally subside when the digestive system is restored to a healthy state and the urine becomes clear, and that this result may be obtained without any treatment specially directed to the liver. I am constantly called upon to treat dyspeptic patients with disordered liver, who have in vain, over and over again, gone through the routine liver treatment of blue pill and purgatives, with only temporary benefit; more especially in summer and autumn, when much more food is usually consumed than the economy requires. On minute inquiry, I find that the key

to their liver symptoms is, in reality, a disordered state of digestion and nutrition, and that the biliary disturbance is secondary and not primary. In other words, I find that the liver is suffering from having to purify the blood of the carbonaceous element of imperfectly-elaborated chyle, and not from idiopathic disease.

Such being the case, mercurials and purgatives only temporarily relieve the congested and irritable state of the organ, which soon returns under the influence of a continuance of the nutritive derangement. By removing the latter, by restoring the digestive and nutritive functions to a healthy state, the incubus of emunctory duties is taken off the liver, and in our climate it generally returns to a normal healthy state without any special treatment being directed to it. Moreover, when the subsidence of biliary derangement takes place in such cases, that is, from the removal of its cause, the improvement is permanent. The liver, ceasing to be called upon to perform emunctory duties, which irritate and disorder it, returns to its normal state, and quietly carries on its customary physiological functions.

The medicinal treatment of defective digestion and nutrition in confirmed dyspepsia is, of course, subordinate to the pathological conditions co-existing,

which it is foreign to my purpose even to enumerate. Suffice it to say, that when defective nutrition is merely the result of the sympathetic reaction on the digestive system of disease existing in regions and organs other than the digestive, the principal medicinal treatment to be pursued is that of the malady in question. When that is removed, the digestive and nutritive power generally rallies without special treatment. If the defective digestion and nutrition is the result of actual disease of the digestive organs, the medicinal treatment must, of course, be mainly directed to subdue such disease. The rules for such treatment will be found in the works which treat of these diseases.

In a large number, however, of the cases of morbid digestion and nutrition that are met with in practice, there is no actual disease of the digestive organs present, at least in the early stage of its existence. The functions of digestion are merely depraved, imperfectly carried on, owing to the perturbing influence of past disease, or to hygienic or dietetic errors. It is to this state that the term *dyspepsia* is commonly and correctly applied, for the digestion is, in reality, difficult, and we may add imperfect. Dyspepsia may exist for many years, and yet after death no lesions be found in the stomach or other organs. It may

be soon followed, on the contrary, by the development of actual organic disease in one or more of the organs which participate in the digestive and nutritive processes—the stomach, intestines, lungs, kidneys, liver, &c.

In simple but confirmed dyspepsia, the hygienic and dietetic treatment already insisted on is, in my experience, of infinitely more avail than medicinal agents. Indeed, a dyspeptic patient who obeys the various hygienic and dietetic rules above insisted on, who avoids past errors, ceases to overstrain his mental faculties, and is free from corroding cares, may often dispense with their aid. It is no doubt by rigid attention to hygienic treatment that homœopathists occasionally succeed in restoring to health dyspeptic sufferers who have failed to recover under medicinal treatment. Steady perseverance also for a lengthened period, often extending over months or even years, may be necessary, even in the absence of organic disease, to secure the recovery of digestive and nutritive power, and eventually that of sound health.

Medicinal agents, however, may always be resorted to in dyspepsia with advantage, as adjuvants, and sometimes they will accomplish in a few weeks what diet and hygiene alone would take as many months to effect. The medicines that are the most useful are

antacids, acids, vegetable bitters, sedatives, and digestive adjutants, such as pepsin, ox-gall, &c.

In some forms of dyspepsia, the gastic juice appears to be secreted in too great abundance, or its acidity is abnormally great, or anomalous acids are developed in the course of the stomachal digestion. Under such circumstances sour acid eructations are experienced; there may be great flatulence from the evolution of gases, which painfully distend the stomach; and pain may also be felt, sympathetically, in the region of the heart or stomach. When these conditions are present, the administration of antacids—soda, potash, or magnesia—often affords great relief. This is so generally known to be the case, that the mineral-waters which contain them, such as soda-water, Seltzer-water, or Vichy-water, have become popular beverages, and are constantly taken with benefit, for acidity and dyspepsia, without medical prescription. They certainly appear often to correct the stomachal acidity, and to facilitate the digestive process.

In these mineral waters the quantity of the alkalies is but small. When it is considered desirable to give the latter medicinally, they are generally given in much larger doses, and must be so given if their chemical effect on the secretions is to be produced.

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From ten to thirty grains of the bicarbonate or acetate of potash, of the bicarbonate of soda, or from ten to thirty minims of the liquor potassæ, taken three times in the twenty-four hours, diluted in any fluid, will generally change in a few days the chemical re-action of the urine; the latter becoming alkaline instead of acid. At the same time the formation and deposit of urate of ammonia after the digestion of food frequently diminishes or even ceases, and the general state of the patient improves; the train of dyspeptic symptoms becoming less marked.

In recent dyspepsia, not kept up by constitutional causes, or by the sympathetic re-action of other disease, or by gross errors in diet, this improvement may be permanent, continuing when the use of the alkali is suspended, and when the urine has recovered its usual acid reaction.

But in confirmed chronic cases, in which the dyspepsia is kept up by some constitutional diathesis, such as gout, or when it is connected with other disease, such as uterine disease undiscovered and untreated, or when perpetuated by errors in diet and hygiene, the improvement is merely temporary. The clearing of the urine, in such cases, appears to be merely a chemical change, induced by the chemical action of the alkali in the blood, and not the result of

the improved digestion and assimilation of food. On the one hand, the dyspeptic symptoms do not abate, and on the other, as soon as the alkali is suspended and the urine regains its acid character, the urate of ammonia deposit re-appears, sometimes with the same profusion as before, sometimes in a diminished quantity. In many instances, even when the digestive system appears to regain its normal power under the influence of alkalies,—the dyspeptic symptoms abating and the urine remaining clear after the cessation of the remedy,—the improvement is only temporary; notwithstanding the greatest attention to diet and hygiene, after a time the urine again becomes loaded, and all the dyspeptic symptoms re-appear.

In both these conditions recourse must be had to other medicinal agents. The alkalies, when given in large doses for a considerable time, impoverish the blood and weaken the economy; so that if their administration for a few weeks is not attended with success, or is only temporarily successful, they should be abandoned. Great benefit may frequently be derived under such circumstances from the mineral acids, nitric, hydrochloric, or sulphuric acids; and from vegetable bitters, such as gentian, calumba, chiretta, quassia, diosma, &c. These agents may be given alone or combined. I always give the acids

largely diluted in water, and tell the patient to take them as a beverage, using a glass tube to save the teeth from contact.

The vegetable bitters are best administered in infusion; but to obtain the full benefit which they are capable of affording, the infusions should be taken in much larger quantities than is usual. Half a pint a day, taken in two or three doses, is not too much. The acids and bitter infusions may often be combined with advantage.

Both acids and bitters act as tonics on the stomach and on the system at large, and their administration is frequently attended with considerable benefit. The effect, however, is very gradual, and they must often, therefore, be continued for some time—one, two, or three months—before the desired result can be obtained.

Sedatives, such as henbane, opium, and its preparations, belladonna, prussic acid, chloroform, &c., and antispasmodics, such as valerian, camphor, musk, myrrh, the ethers, &c., act principally in subduing pain, and controlling spasm and abnormal conditions of innervation.

These various medicinal agents may be combined with advantage. Their administration, however, does not in any way absolve the medical practitioner

and his patient from the neeessity of attending most serupulously to the dietetie and hygienie rules developed in the preeeding pages. It is only by uniting striet attention to these rules with medieinal treatment that the latter ean be made really beneficial. Without dietetie and hygienie care, no medieine, however judiciously seleeted, ean restore to health a patient whose digestive system and nutritive powers have been seriously impaired.

In some exeeptional instanees the depraved state of the digestion, and the defeetive nutrition whieh follows, persist as eonstitutional eonditions, notwithstanding the removal of all eo-existing disease, and the most rigid and serupulous medieinal, dietetie, and hygienic treatment, eontinued for months or even years. In some of these cases there may be obseure structural disease of the stomaeh, of the liver, or of other organs conneeted with digestion, which it is foreign to my purpose here to investigate. With others, sueh forms are evidently the mere result of a confirmed morbid habit, or of some eonstitutional state, sueh as the gouty diathesis transmitted by heredity, of some unfavourable hygienic eondition, or of mental anxiety and distress. This latter eause is a fruitful souree of eonfirmed dyspepsia, with all its eoncomitant evils; and as long as grief and sorrow

exercise their depressing influence, all efforts to control the dyspeptic state of the patient utterly fail. Indeed, it is by depraving and disordering the digestive and nutritive functions that grief kills; not by "breaking the heart," as is popularly supposed.

The gouty diathesis, when it is the result of hereditary taint, has proved in my experience the cause of some of the most intractable forms of dyspepsia, both in male and female, that I have met with. Indeed, I believe that dyspepsia, recognising this cause, is in some instances quite incurable, and can only be palliated. It is a sad legacy that the gouty, from self-indulgence, often leave to their children, even when they themselves are free from it. Singularly enough, it does not show itself, necessarily, in all the children of a gouty father or mother, but only in one or more of the number. The children of gouty parents ought more especially to follow the hygienic and dietetic laws laid down in these pages, if they wish to escape much suffering. As a rule, they ought to be all but water-drinkers throughout life; they have to pay the penalty of their progenitors' excesses or dietetic errors. If the gouty diathesis is strongly marked, they should be most moderate and abstemious in their food habits, and lead as active and muscular a life as possible. Indeed, they should

never lose sight of the fact, that a miserable, gouty old age may be their fate, should their life be prolonged, unless they make many sacrifices to ward off the impending danger.

In such cases as those we have been describing, in which dyspepsia, or defective digestion and nutrition, persists, notwithstanding the most judicious and careful treatment, the urine remaining turbid and loaded with morbid salts after digestion, the patient must not despair. It would be folly to give up all efforts to recover health, as many feel inclined to do; on the contrary, he should follow out more rigidly and scrupulously than ever dietetic and hygienic rules, and that *indefinitely*, in the hope that sooner or later the digestive functions may thereby be restored to a healthy state, or that the dyspeptic condition may, at least, be limited and controlled.

These rules may be recapitulated in a few words. The confirmed dyspeptic should give up late hours and the dissipations of society, and if possible live in the country. If not possible, if he is a denizen of towns, he should endeavour to reside out of their immediate influence, in the parts the least densely inhabited, or in the suburbs. Regular walking exercise should be taken, and the amount should be gradually increased; and

that in nearly all weathers. From seven and a half to eight and a half hours' sleep or rest in bed should always be allowed; the hours for retiring and for rising being invariably the same. The hours for meals should also be established, and adhered to with the strictest regularity. All, or nearly all, fermented and alcoholic beverages should be discarded, and water taken instead; and stimulating non-fermented beverages, such as tea and coffee, should be taken very weak and in moderation. There should not be more than three meals daily, and one only of the three should be a solid one; that is, consist of flesh, fowl, or fish. The intervals between these meals should be at least four hours; and no food, solid or fluid, should be taken between meal hours, or within two or three hours of retiring to rest. No spices or seasonings, no uncooked vegetables, should enter into the dietary. It should be varied, and consist of the very lightest kind of nutritious food, vegetable and animal, such as of bread, potatoes, milk, eggs, butter, fish, fowl, game, and meat, and more of the former than of the latter. Such a dietary, be it remembered, is not a low, but merely a *light* dietary.

Lastly, the quantity of the food should be rather less than what is usually ingested in health. Should loss of weight occur, the food amount must be gra-

dually increased until the loss ceases. No preconceived dietetic scale as to the amount of food required will take the place of periodical weighing: the food requirements, or power of extracting from food nutritive elements, and of assimilating them, varying, as has been repeatedly stated, within very extreme limits. We must not forget that many will thrive and do well on an amount of food which would be quite insufficient to others, inasmuch as it would not in any respect satisfy the wants of their economy. Attention to individual peculiarities, pertaining to the hours and frequency of meals, and to their nature, is more especially necessary in the case of the confirmed dyspeptic.

When digestion is inefficient, and the economy is positively poisoned by imperfectly-elaborated chyle, among the symptoms usually observed, constipation occupies a very prominent position. It is usually treated by aperient medicines, often combined with blue pill or mercury, owing to the co-existence of congestion and disturbance of the functions of the liver.

Purgatives really relieve; but for a time only; and their habitual use increases the mischief, especially when they are combined with mercurials. The liver and intestines, accustomed to be stimulated by

medicinal agents, become more and more physiologically torpid, functionally inactive, and only act, at last, when medicinally coerced. These perpetual alternations between inaction and overaction contribute to aggravate the digestive inefficiency.

In such cases the constipation ought to be considered as merely the result of a defective state of digestion, and of the elaboration of unhealthy bile, which does not physiologically stimulate the intestines to action. The real and permanent remedy is not blue pill, calomel, and purgatives, but the restoration, principally through hygienic and dietetic means, of the digestive and nutritive functions. When they really are restored to a healthy state, the urine becomes clear and free from morbid salts, and the liver secretes healthy bile, which, generally speaking, stimulates the bowels to healthy and spontaneous action.

Until this result is attained, the physician and his patient should not weakly succumb to the constipation, meeting it by purgatives, but battle with it. Firstly, dietetic and hygienic means should be tried; brown bread, or oatmeal porridge; ripe fruit in summer; stewed fruit, pears, apples, prunes, figs in winter; the shower bath, or cold sponging in the morning; a glass of cold water on waking; a dessert

spoonful of sweet olive oil night and morning; or half an hour's walk before breakfast. These various agencies, combined or singly, will often turn the scales, and produce a regular action of the bowels without having recourse to medicine. Should they fail, about a quarter or half a pint of cold water, at summer heat, say from 50° to 70° should be slowly injected into the bowel, half an hour after breakfast, and retained from five to ten minutes; indeed, that quantity of water only should be injected, which the patient can retain with comfort. If the water returns alone, it is generally a proof that the want of action is not in the lower bowel; and when such is the case, the temporary inaction is not of so much importance in a health point of view; we can therefore better afford to wait for nature unaided to act.

Should, however, the cold enema fail two mornings successively, it becomes imperative to come to the assistance of the inactive upper bowel, and an aperient should be taken. The aperient should be of the mildest kind, the object not being to purge the patient, but merely to obtain on the third morning one natural but satisfactory motion. There are few cases—even of constitutional constipation—that are not much improved, if not entirely remedied by a steady perseverance in this plan of

conduct, at least in early and in middle life. With the aged, constipation is often merely a phase of the increasing torpor of organic life, and, as such, is incurable. When this is the case, purgatives become indispensable. To the habitual dyspeptic, on the contrary, it is all but a condition of recovery that he should be freed from the necessity of daily taking purgative medicine. This fact ought to be more generally appreciated than it is, both by the profession and by the public.

There are some other facts connected with the history of habitual constipation, which deserve notice. When the alvine evacuations are confined, they are generally small in volume; the fæces lose their soft, moist character, from the gradual absorption of the fluid element in the large intestine, where they principally lodge; and the result is a hard compact motion, occupying very little space. The alvine evacuations, even in health, it will be remembered, only weigh a few ounces in an adult rationally fed. Thence, in the mind of the patient, the often erroneous impression that there must be a lodgment somewhere, and a continually renewed attempt to increase the volume of the fæces by purgative medicine. As long as the motions which take place, under the influence of medicine are loose or semi-loose, they

are voluminous, and thereby satisfy the preconceived notions of the patient; but as soon as they again become constipated and small in volume, he reverts to his former impression, and, under the influence of these ideas, purgatives are taken or given, often to a very pernicious extent.

It is not only in confirmed constipation that erroneous views are frequently entertained as to the healthy amount of the alvine evacuations. Many persons appear to think that the more abundant they are, the more satisfactory and the more conducive to health is their own state or that of their patient. This is a very great error; the fæces, as we have seen, ought only to contain the indigestible residue of food, with a little bile, and a few salts. When they are very abundant or voluminous, it is generally owing to more food having been taken than the stomach and digestive organs can chymify; such being the case, the surplus escapes partly digested, or even unchanged, through the bowels, after overburdening and disturbing the entire intestinal canal.

Many a hypochondriac half destroys himself by purgatives, under the influence of this egregious mistake. Many a doting mother, imbued with this fatal error, does her best utterly to destroy the di-

gestive system of her children; on the one hand by overfeeding them, and on the other, by drenching them with purgatives, in order to obtain the voluminous motions which, in her blind ignorance, she deems necessary for their health.

In concluding this survey of the functions of digestion, and nutrition in health and disease, it may be desirable briefly to recapitulate the leading facts and opinions conveyed in the course of the work.

I have endeavoured to prove that defective digestion and nutrition—often unrecognised and untreated—is the cause of a vast amount of functional and structural disease, more especially in the chief emunctory organs—the kidneys and the liver; and that it prepares the way for many morbid conditions, usually studied as entities or individualities, and considered only with reference to the causes which have more immediately produced them.

I have also attempted to show that, apart and in addition to the general symptoms of defective digestion usually studied and recognised, the examination of the urine—physical, microscopical, and chemical—generally affords the most delicate and surest test of the condition of the digestive and nutritive functions. If the latter are defective, a few hours after the ingestion of food, the urine is generally found to

contain morbid salts, and to become turbid on cooling.

The presence of these morbid salts, under such circumstances, is a proof of the imperfect digestion of food; imperfect nutrition following as a necessary consequence. Their existence, therefore, implies danger to the organization; and a danger not the less real that it may be more or less remote. This clinical fact affords the physician the safest and most tangible guide in the medicinal, dietetic, and hygienic treatment of his patient. The patient also, when aware of the meaning and importance of urinary deposits, finds in the turbidity which they usually occasion in the urine an easily recognised guide in the management of his diet, and in that of the daily routine of his life.

Many, very many, are ever unconsciously floating into disease, suffering, and death, through the silent operation of defective nutrition. And yet the morbid nutritive changes which, as we have seen, so often *precede* disease, might generally be arrested, were the unconscious sufferer aware of the danger that accompanies and follows their existence.

The analysis of the functions of life contained in the preceding pages would be incomplete, were I to omit once more emphatically to recognise the mysterious vital influence which controls all organic manifestations.

The mighty Author of all things has endowed all animated nature with an inherent power to live and to reproduce the parent organization; but the reason and the variations of this vital power can only be found in His will. To our finite comprehension, its nature is totally incomprehensible, and its manifestations are only very partially reduceable to rule. This inherent vitality is not only different in each species of animals or plants, but also in each member of the same species. We may, through the application of the laws developed by science and by experience, estimate its strength in individual cases, but only within very narrow limits.

In health, as in life, "the battle is not *always* to the strong, nor the race to the swift." Some whose family antecedents are good as regards constitution and health, and who have always appeared strong and hardy, in the hour of trial show no real vital strength, and at once succumb, if exposed to hardships, or if attacked with disease. Others, on the contrary, who can boast neither of good family antecedents nor of per-

sonal health, live on through every untoward ordeal, physical and mental, and eventually attain old age. With them the "grasp upon life" is so strong that they victoriously resist every influence, however unfavourable to life. As children, they may be neglected and badly fed; as men, they may be exposed to fatigue, to mental distress, to malaria and to disease in every shape, and yet through their strong inherent vital power, they resist every morbid influence, or, succumbing for a time, eventually rally and regain their footing on the shores of life.

Belonging to this class are—the habitual drunkard, who yet attains old age; those who pass through threescore and ten years of disease and physical suffering; those who live long years in malarious, death-giving districts; the soldier who, if he escapes the enemy's ball, passes scathlessly through twenty campaigns; or the barrister who reaches the woolsack after half a century of mental toil and bodily inaction.

In all, the vital principle must have been exceptionally powerful, the hold upon life must have been exceptionally great, from the moment they drew their first breath. They are exceptions to the general rules which regulate health and life, and the exception has its explanation in this very intensity of the vital

power which we recognise in its results, but can neither comprehend nor always foresee.

That such exceptions should occur is one of the most bountiful dispensations of Providence. Thus is the hope of long life given to all, even to the weak and the sickly. No human science or skill can unerringly estimate the inherent vital power of a fellow-being, however stricken by illness. If no organ indispensable to life is irretrievably compromised, the vitality of the sufferer may yet enable him to rally, to shake off disease, and to live to the allotted age of man.

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